ARMY NATIONAL GUARD

UNIVERSITY OF MICHIGAN

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MAIN READING ROOM

HEARINGS

BEFORE THE

SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

FIRST SESSION

SUBCOMMITTEE ON DEPARTMENT OF DEFENSE APPROPRIATIONS

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ARMY NATIONAL GUARD

THURSDAY, MARCH 19, 1959.

WITNESSES

HON. CHARLES C. FINUCANE, ASSISTANT SECRETARY OF DEFENSE (MANPOWER, PERSONNEL AND RESERVE)
HON. WILBER M. BRUCKER, THE SECRETARY OF THE ARMY
MAJ. GEN. D. W. TRAUB, DIRECTOR OF ARMY BUDGET
MAJ. GEN. D. W. McGOWAN, CHIEF, ARMY DIVISION, NATIONAL GUARD BUREAU
MAJ. GEN. ROBERT S. MOORE, SPECIAL ASSISTANT TO COMPTROLLER, DEPARTMENT OF DEFERSE

ARMY NATIONAL GUARD APPROPRIATION

Obligation and requirement schedule

[Dollars in thousands]

	Program and description	Obligations Jan. 31, 1959 (actual)	Obligations Mar. 31, 1959 (estimated)	Obligations June 30, 1959 (estimated)	Additional Requirements	Revised funding requirements
7000	Military personnel costs	$122,424	$150,000	$207,454	$11,600	$219,054
	Annual active duty for training P/A	27,483	27,900	[1] 38,741	[2] 900	39,641
	Pay during drills	58,078	74,900	[3] 95,789	[4] 9,600	105,389
	6-month Federal status program	23,656	31,100	[5] 46,040	[6] 1,100	47,140
	Others	13,207	16,100	26,884		26,884
7100	Command and management	997	1,200	1,560		1,560
7200	Training	980	1,250	2,519		2,519
7300	Materiel	2,277	2,900	6,400		6,400
7400	Supplies and repair parts	8,177	10,600	14,050		14,050
7500	Services including equipment maintenance	59,035	76,200	102,310		102,310
7600	Antiaircraft defense	5,459	7,200	[7] 8,600	[8] 1,600	10,200
	Total obligations (includes reimbursement	199,349	248,750	342,893	13,200	356,093
	Appropriation			342,093	13,200	355,293

[1] Limits participation in annual active duty for training in 4th quarter (within end strength of 400,000).
[2] Provides for the revised rate of pay based upon obligations reported for training consummated in the first half of fiscal 1959.
[3] Limits participation to 44 armory drills, a reduction of 4 drills below the 48 programed.
[4] Provides for 48 armory drills.
[5] Limits the 6-month training input to 52,100 trainees and necessitates deferment of an additional 2,900 to fiscal year 1960 to meet the end strength of 400,000.
[6] Provides for a 55,000 trainee input.
[7] Limits acceleration of NIKE program and will support but 1,650 man-years of an 1,816 program.
[8] Provides for the revised technician structure and program changes approved by the Department of the Army.

Mr. MAHON. Gentlemen, will you please come to order.

We are pleased to have you here, gentlemen, for a special hearing.

LETTER TO CHAIRMAN OF APPROPRIATIONS COMMITTEE

The Secretary of Defense wrote a letter to the Appropriations Committees of the House and Senate and also to the Armed Services Committees of the House and Senate, that is, to the chairmen of those committees, with regard to a problem which has arisen in connection with the financing of the National Guard.

I will place that letter in the record at this point.

(The letter referred to follows:)

THE SECRETARY OF DEFENSE,
Washington, March 16, 1959.

Hon. CLARENCE CANNON,
Chairman, Committee on Appropriations,
House of Representatives.

DEAR MR. CHAIRMAN: The Department of the Army has found that due to unforeseen financial requirements and after full utilization of the available funds, certain adjustments will be required in the planned Army National Guard program for fiscal year 1959.

As you know, the President originally recommended to the Congress an Army National Guard program and budget to attain a year-end strength of 360,000 for fiscal year 1959. However, the Congress (title III, Public Law 85–724), prescribed "that the Army National Guard shall be maintained at an average strength of not less than 400,000 for fiscal year 1959." In view of this congressional action, the administration revised its plan to achieve 400,000 paid status, and the Department of Defense, within the funds made available to it, has sought by every practical means to achieve and maintain the prescribed strength objectives.

Last fall it appeared that the $342.1 million appropriated by the Congress was sufficient to cover the objectives of the program, including $5.1 million for the pay increases of civilian employees of the National Guard as authorized by Public Law 62–463. The absorption of the authorized civilian pay increase appeared possible at the time for the reason, among others, that the full number of 6-month trainees included in the original plan would not be required. However, since then unforeseen financial requirements have developed, as follows:

(*a*) Pay of Army National Guard military personnel has increased because of a higher pay grade structure caused partly by improved reenlistments for an amount of $8.1 million.

(*b*) Attendance at paid drills increased 2.5 percent creating an additional cost of $2.4 million.

(*c*) The Army National Guard air defense program was accelerated in conjunction with the total air defense program, with increased costs of $1.6 million.

(*d*) Restatement of the requirement for 6-month trainees $1.1 million.

The above requirements, totaling $13.2 million, must now be taken care of within the total of $342.1 million, and as a result certain adjustments in the program will be necessary to stay within the amount appropriated. These adjustments involve either some reduction in maintenance and support expense, a reduction in the number of paid drills, a reduction in strength, or some combination of these. We are studying this problem on an urgent basis with the Department of the Army and the National Guard Bureau to achieve an optimum program within available funds.

Since there are only a few months remaining in this fiscal year it will, of course, be necessary for the Department of the Army to take prompt action. However, before any action is taken we would like to put before you and any interested members of your committee the full details of the optimum plan to meet this situation which we expect to have completed and ready to discuss with you within the next few days. Secretary Brucker and Assistant Secretary of Defense Finucane are available to furnish your committee with this information.

Sincerely,

NEIL MCELROY.

PROVISION IN PUBLIC LAW 724 CONCERNING NATIONAL GUARD STRENGTH

Mr. MAHON. I have a copy of the Defense Appropriation Act, Public Law 724, 85th Congress, that is our bill of last year, and I am looking at page 5, the first paragraph at the top of the page.

I will read the proviso which begins about eight lines down which states as follows:

Provided further, That the Army National Guard shall be maintained at an average strength of not less than 400,000 for the fiscal year 1959.

As we know from the letter from the Secretary, some difficulties have arisen, and it has been suggested by the Secretary of Defense, Mr. Neil McElroy, that about $13.2 million of additional funds will be required to meet the standards set up in the appropriation bill of last year which I quoted a few moments ago.

Mr. Finucane, Secretary Brucker, who will give us information on this?

Secretary BRUCKER. I will respond for the Army, Mr. Chairman.

Secretary Finucane, the Assistant Secretary of Defense for Manpower, Personnel and Reserves, will speak for the Secretary of Defense.

Mr. MAHON. Very well.

Give us a picture of what your problem is, Mr. Secretary.

REASONS FOR SHORTAGE OF FUNDS

Secretary BRUCKER. We will enter the fourth quarter of the fiscal year on April 1. After rather careful consideration of the problem of complying with the direction of the Congress for the 400,000 end strength for the 1959 fiscal year, it is very clear that we cannot reach that 400,000 unless certain things are done. It is also very clear that the money which was originally appropriated by the Congress is running out.

The way this situation occurred was this: You will remember that a year ago the administration budget requested sufficient moneys for 360,000 men for the National Guard and 270,000 for the USAR. We will leave the USAR out of it because they are not involved in this picture. The number was 360,000 for the National Guard. Congress at that time raised that figure to 400,000 men, and supplied certain money, as you have stated, in the budget.

Following the adjournment of Congress, which was in August of last year, guidance was given to us by the Secretary of Defense to go forward with the figure which had been approved by the Congress. We have been endeavoring since that time to follow the figure of 400,000.

Mr. MAHON. Would it be proper for me to point out that you supplied us with the figures which were supposed to be adequate to maintain the guard at a 400,000-man level, did you not?

Secretary BRUCKER. That is right.

Mr. MAHON. And we provided the funds?

Secretary BRUCKER. We do not in any sense ascribe that Congress provided too little at that time on the basis of what we furnished. That is not the case at all.

It is our position that since that time, events have occurred which have indicated otherwise. In other words, these factors developed that I now give you for the record:

First, there is the matter of higher pay rates from improved reenlistments and longevity which no one had any idea would occur. In other words, our reenlistments were better in the higher pay rate structure. The best estimate we have after watching it very carefully month by month, will be $8.1 million in excess of what we estimated a year ago.

Then in addition to that there was improved attendance at the weekly drills. Based upon statistics and everything that we had known prior to that time, we predicted a certain amount which would be necessary for the paid weekly drills. That amount was exceeded by the attendance, and the excess amounts to $2.4 million. It is not great but it is something, and it all adds to the total.

With respect to the National Guard taking over a portion of the air defense problem, you will remember we had been pushing that program. It was accelerated more than we thought it would be by $1.6 million.

The fourth thing which added to the total was the matter of the 6 months trainees restored to 55,000 in order to bring the strength up. That is $1.1 million more, the total of all four factors I have mentioned is $13.2 million.

Each of these four items I have here mentioned were very carefully estimated a year ago. No one could tell, however, what the exact amount would be and as we progressed into this fiscal year somewhat further, we could see we would fall short. That figure is $13.2 million.

POSSIBLE METHODS FOR SAVING $13.2 MILLION

It has been suggested in the communication by the Secretary of Defense that there be three courses adopted for the purpose of saving this amount of $13.2 million.

The combination of these that the Army would be forced to take follows:

The first is to defer logistical support. This is a vital thing in connection with the National Guard, of course. The total deferred would be $2.9 million. It will have to be paid sometime but it would be deferred and we would not have it during the time we had planned to have it.

Mr. MAHON. What would that actually be?

Secretary BRUCKER. I will give you the breakdown in a moment if you will permit me to finish this so you will get the full picture.

The second area in which we could save would be deferring the 6-month trainees which I just mentioned here, and save out of that $1.1 million.

The third course is to cancel four drills. That would save $9.2 million. That would be four drills out of the 13 weeks in the last quarter. I call your attention to the fact that that would not be level because some of these units would be going to camp in June and we would not have a full quarter to operate.

However, out of the 13 drills which would be normal and usual, we would have to cancel 4.

The drill schedule right before going to camp is most important for preparing for camp, and that is the very worst portion of the year to cancel drills.

In order to cancel drills the National Guard of the States would have to know of the plan at the earliest possible date so that they could accommodate that cancellation of paid drills to the very tight remaining period of 13 weeks.

That total then would be $13.2 million. Those are the items on both sides of the ledger about which you have asked me, Mr. Chairman.

Now with respect to this other item, "Logistical support."

You asked me what deferring logistical support would mean. That would mean canceling shipments to depots and canceling interstate lateral redistribution of equipment in connection with reorganization. Test sets and tool sets for new equipment, and parachute replacement would be deferred. The total of that would be $2.9 million.

FAILURE OF ADMINISTRATION TO REQUEST NEEDED FUNDS

Mr. MAHON. Why was not a supplemental or a deficiency estimate submitted to this Congress on this matter?

Secretary BRUCKER. I imagine Secretary Finucane can tell you about that. We are the operating agency and we would be glad to answer any questions in our operating field.

Mr. MAHON. What about that, Secretary Finucane?

Mr. FINUCANE. The administration does not want to ask Congress in this instance for a deficiency appropriation because the President's original program was not the program which was finally handed to us. I believe there is a feeling that the Congress has gone ahead of the administration on this matter and they should be advised as to the present situation in this program.

I would like to make one or two comments about Secretary Brucker's statement, which was very good and very accurate, of course.

REASONS FOR DEFICIENCY

These deficiencies are not caused by our deviating from the 400,000-man position, and indeed we are not deviating from the 400,000-man position.

If these deficits had shown up earlier in the year we could have perhaps reduced strengths to absorb some of the deficit because I think you understand how regretful we are to have to call off drills at this particular time. I think we are all in accord now this late in the year that in fact if we did not adhere to our 400,000 program, which we intend to do in line with the letter of February 6, 1959 on this subject which I directed to you, Mr. Chairman, that we could not accomplish the objective. So we will continue with the strength program as planned and finish the year, I am sure, with the objective of Congress right on the nose.

It is a very difficult thing to estimate 15 or 18 months in advance exactly what is going to happen.

In the matter of the Guard, which we based our estimates of drill attendance on 1956–57 figures, and indeed in the case of our estimate of the people who would reenlist, we found that our record in 1958 and 1959 is very much superior, for which we are all very happy.

To give you an example, there were 11,000 fewer losses in the Guard during the first half of fiscal year 1959 than we had anticipated.

In other words, we got 11,000 more reenlistments.

Mr. MAHON. Off the record.

(Discussion held off the record.)

POSSIBLE TRANSFER OF FUNDS

Mr. MAHON. Here is one question which occurs to me to be pertinent: Can you by any transfer operation find money for this program?

Secretary BRUCKER. My answer to you is "No, sir." We have gone all through that. We wish we could. We have gone over all the possible sources and there are no other funds which could be used.

NO OFFICIAL REQUEST FOR FUNDS

Mr. THOMAS. Let me get one thing clear in my mind.

Is the Department here seeking a request of $13.2 million? Are they asking for this money?

Mr. FINUCANE. No, sir.

Mr. THOMAS. You are not?

Mr. FINUCANE. No, sir.

Mr. FLOOD. Why not?

Mr. SIKES. Is the Department of the Army allowed to ask for this money?

Mr. FINUCANE. The administration policy is not to ask for it.

Mr. THOMAS. These are high-ranking officials. They are not children. They are Secretaries, the highest level of the Department of Defense.

If they cannot ask for it, who in the world can? Do you want it or not?

Mr. ANDREWS. May I ask one question here?

Mr. MAHON. Please let the witness answer Mr. Thomas.

Mr. FINUCANE. We would not like to call off these drills, but we are going to call off the drills rather than ask for a deficiency appropriation.

Mr. THOMAS. Let us put it on the line. Do you want this money or do you not?

Mr. FINUCANE. I personally wish we had enough money. I deplore this calling off of drills.

Mr. THOMAS. You are speaking in your official capacity, and in your official capacity you want the money?

Mr. FINUCANE. We are not asking for the money.

Mr. SIKES. Officially you are not asking for the money?

Mr. FINUCANE. That is right.

Mr. THOMAS. What about you, Mr. Brucker?

Secretary BRUCKER. We are an operating agency of the Department of Defense. We have no right to go over the head of the Department of Defense to solicit any funds of any kind at any time.

I can speak to you personally about it if you want me to speak personally about it. I am not asking for funds here because as Secretary of the Army I have no authority to do that.

Mr. THOMAS. We are talking to you in your official capacity as Secretary of the Army.

Secretary BRUCKER. In my official capacity as Secretary of the Army I have no right. The Secretary of Defense or the Defense Department is the agency for authorizing requests for funds to the Congress.

Mr. THOMAS. We ought to have Secretary McElroy, then.

Mr. MAHON. In line with Mr. Thomas' question, the Army did ask the Secretary of Defense to make arrangements to permit you to ask for the money through the budget or otherwise. Is that not true?

Secretary BRUCKER. That is correct.

Mr. MAHON. What response did you get?

Secretary BRUCKER. I received no direct response. We are here today to respond to that at your request.

Mr. FLOOD. This is an attempt to do indirectly something they haven't the courage to do directly. I am for giving them the $13 million, put in the same language this year, and make it apply also to the Army and Marines as well as National Guard and Reserve, and stick it down their throats in spades.

Let's see if Congress has any authority left.

Mr. MAHON. Are you finished, Mr. Thomas?

Mr. THOMAS. For the present.

Mr. SIKES. Did you request permission of the Department of Defense to seek this money through the regular channels, through the Budget Bureau?

Secretary BRUCKER. There being no appropriation for it there is no way in which I could request that.

I did request that they consider a supplemental on this matter which would amount to a total of $13.2 million.

Mr. SIKES. Requested of whom?

Secretary BRUCKER. The Secretary of Defense.

Mr. SIKES. Were you refused?

Secretary BRUCKER. No, sir; I have never been refused. This letter to you from the Secretary of Defense resulted, I presume, from the initiation of the request.

Mr. SIKES. A letter which came to Congress and was directed to the chairman of the committee.

Secretary BRUCKER. Yes.

Mr. SIKES. You have not been authorized to ask for a supplemental appropriation?

Secretary BRUCKER. That is correct.

Mr. SIKES. Therefore, you cannot officially ask for a supplemental appropriation?

Secretary BRUCKER. That is exactly right.

Mr. SIKES. But instead you can tell the Congress what is going to happen to your program if the funds are not approved?

Secretary BRUCKER. That I can.

Mr. SIKES. That is what you are now doing?

Secretary BRUCKER. That is what I have done, I have endeavored to tell you that.

Mr. SIKES. Because of the fact you are operating under certain regulations, you are not permitted to come to Congress and officially ask for money unless your request to the Secretary of Defense for a supplemental appropriation had been approved?

Secretary BRUCKER. That is right. There is no authority on my part to come unless that is done.

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Mr. SIKES. In view of the fact this letter has come from the Secretary of Defense you are here to speak to the contents of that letter and to tell the Congress what will happen to the program for 400,000 members of the National Guard which it authorized and directed unless additional funds are now provided.

Secretary BRUCKER. That is precisely true, yes.

Mr. SIKES. In effect the Congress has directed a specific level of operations within the National Guard. Because of circumstances which were not foreseen you do not have the money to carry on that program now at the level specified. Is that correct?

Secretary BRUCKER. We do not have the money to carry that program out.

Mr. SIKES. Apparently because the administration did not itself recommend this level of operation the administration is not now willing to ask Congress for enough money to carry on the program which Congress directed.

Secretary BRUCKER. That is a matter Mr. Finucane will have to speak on.

Mr. FINUCANE. That is correct; yes.

Mr. SIKES. Is that correct?

Mr. FINUCANE. With one exception. I am sure you did not mean it, but I think the inference is that we will not meet the 400,000 objective. I assure you we will.

Mr. SIKES. I speak of the training limitations which the Secretary pointed out in his letter. These are the activities which will be curtailed.

Mr. FINUCANE. That is right.

Mr. SIKES. They are associated with the overall directive which Congress issued in my opinion.

Mr. FINUCANE. The 48 drills have been customary for many years.

Mr. SIKES. These are parts of the regular program which will have to be dispensed with unless additional money is provided?

Mr. FINUCANE. That is right.

Mr. SIKES. You are here to tell Congress what will happen if Congress does not see fit to provide you with additional money.

That is all you can do under the regulations under which you work. Is that correct?

Secretary BRUCKER. That is all we can do.

Mr. FINUCANE. We are here to answer your questions.

ACHIEVEMENT OF 400,000 STRENGTH

Mr. MAHON. I do not think we have reached the 400,000 and we may not reach the 400,000, and you will not carry out the letter of the law, will you?

Mr. FINUCANE. As stated in the letter we sent you, Mr. Chairman, we will have an end strength of 400,000. We hope to have an average strength starting from 392,000 of about 394,000 and we will be 402,000 on the 1st of May if we maintain this schedule.

Mr. MAHON. You people are better informed as to technical matters and you can speak authoritatively on this, but just because an executive does not favor legislation which becomes a law is ordinarily not used as a reason for not requesting necessary funds to implement the law of the land. I am a little puzzled here about this situation.

Mr. FINUCANE. In the course of action proposed here there is no violation that I know of of any existing statute. In other words, if the Secretary of the Army feels he has to call off four drills that is not a violation.

Mr. MAHON. Does not the statute require a certain minimum level of drills, and so forth?

Mr. FINUCANE. It requires certain numbers of people; yes, sir. We intend to meet the prescribed numbers.

Mr. MAHON. In other portions of the law having to do with the National Guard.

Mr. FINUCANE. With the 48 drills, sir?

Mr. MAHON. Don't you provide for the drills?

Mr. FINUCANE. We always want to have 48 drills but it is within the discretion of the Secretary to have less. Indeed, in my experience in 4 years we have had combinations in which physically we did not have exactly 48.

Mr. MAHON. I question the judgment of the Defense Department in not requesting the needed funds for the National Guard.

Mr. FORD. Will the chairman yield?

Mr. MAHON. Yes.

Mr. FORD. Is it not true, however, that in this situation there is related the question as to whether or not the Executive as Commander in Chief has the authority to set up the size of the Active Forces and also the Reserve Forces?

This is an unresolved question constitutionally.

Mr. MAHON. Yes.

Mr. FORD. So it is not all black and white in this area as to whether or not the President is refusing to carry out the law of the land. That is an inherent issue in this problem as it is in some of the other problems we have run into over the years. That is so with this administration and other administrations.

Mr. MAHON. I am just exploring this problem as I speak. I may be in error, but the more I speak about it the more I am convinced that perhaps the principle here would require a forthright request of Congress for these funds to implement a law of the land.

The mandatory provisions of the law were written in the Senate and compromised in conference. It was a compromise.

Members of Congress cannot always get their will with respect to every matter, and neither can the executive branch.

However, when the law is written, it seems there is nothing else to do but to carry it out in keeping with the spirit of the law. I am somewhat concerned about this problem.

Mr. SIKES. Mr. Secretary, would you tell us what your problem has been with reference to reaching the 400,000 strength which Congress specified should be the average strength of the National Guard? It appears to me that you are not, in fact, going to reach an average of 400,000. Consistently we have run a little below 400,000 during fiscal year 1959 and the fiscal year is now getting on toward a close

What is the problem in reaching an average strength of 400,000?

Secretary BRUCKER. On the matter of 400,000, if we were to have the amount of money that is here stated, I am now speaking with respect to the $13.2 million, we could reach the 400,000 figure by the end of the fiscal year and certainly would do the best we could to live up to the request of Congress.

Mr. SIKES. Even so, you would not reach an average for the year of 400,000, would you?

Secretary BRUCKER. No, sir; we would not.

Mr. SIKES. If you do not receive this additional money, does that mean that your strength figure is going to drop further below that average of 400,000, which the Congress specified than would otherwise be the case?

Secretary BRUCKER. It will.

Mr. SIKES. By about how much?

Secretary BRUCKER. By about 3,000 or thereabouts.

Mr. SIKES. What has been the difficulty in achieving the 400,000 figure up to this point?

Secretary BRUCKER. The difficulty has been the authorization of 6-month trainees. That is a part that now remains to be given the final money that will put it over, or up to 400,000.

Mr. SIKES. Has the difficulty in reaching 400,000 been entirely one of money?

Secretary BRUCKER. It has been one of having sufficient money to enlist and enter into training sufficient 6-month trainees.

Mr. SIKES. Has this been due to the manner in which the money voted by Congress has been allocated by the Bureau of the Budget or has it been due to a shortage of money in the appropriation?

Secretary BRUCKER. It is very difficult to distinguish between those two for this reason——

ALLOCATION OF FUNDS

Mr. SIKES. Either Congress gave you enough money or it did not. If it gave you enough money, either the Department has allocated that money in time to take care of National Guard needs or it has not.

Secretary BRUCKER. There is a slight difference between the amount of money that Congress appropriated or gave us and that which we allocated to the subdivision of trainees of $1.1 million that we must have if we are going to reach the 400,000.

Mr. SIKES. Of the $1.1 million, that, in itself, would not affect you greatly, I would think.

Secretary BRUCKER. About 3,000 trainees.

Mr. SIKES. What about the allocation of funds? Has the allocation of funds been held back in any way so that you have been handicapped in your program?

Secretary BRUCKER. The allocation of funds has been on a different basis between us concerning the way in which the money should be allocated for strength.

Mr. SIKES. Has the money been allocated as you requested it?

Secretary BRUCKER. Not always; no.

Mr. SIKES. Could you have reached a higher average strength if the money appropriated by Congress had been allocated as you requested it?

Secretary BRUCKER. As events turned out, it would appear that that is correct. That it could have been reached on a different basis.

Mr. SIKES. Could you provide a table for us showing your requests for funds and the actual allocation of funds?

Secretary BRUCKER. Yes; we could provide that for the record.

(The table referred to follows:)

Army National Guard, fiscal year 1959

[In thousands]

Program by activities	President's request		Appropriated	Apportionment	
	Initial budget	Amended budget		Initial (Sept. 17, 1958)	Revised (Mar. 17, 1959)
	(a)	(b)	(c)	(d)	(e)
7000 Military personnel costs	$172,040	$184,414	$211,814	$203,783	$206,714
7100 Command and management	1,460	1,460	1,460	1,560	1,560
7200 Training	2,500	2,500	2,519	2,519	2,519
7300 Materiel	6,400	6,400	6,400	6,400	6,400
7400 Supplies and repair parts	14,000	14,000	14,000	14,000	14,000
7500 Services, including equipment maintenance	93,000	93,000	97,300	102,300	102,300
7600 Antiaircraft defense	8,600	8,600	8,600	8,600	8,600
Total (for direct obligations)	298,000	310,374	342,093	339,162	342,093

NOTE.—Initial apportionment actions shown in col. (d) above, reduced the 6-month training program and officers' pay and allowances by $8,031,000; provided $5,100,000 for civilian pay act costs which were not provided for in the appropriation; and established a BOB reserve of $2,931,000.
Revised apportionment action as shown in col. (e) above released the BOB reserve of $2,931,000, with the result that the entire amount appropriated has now been made available for use.

Mr. FORD. May I ask a question?

Mr. SIKES. Of course.

Mr. FORD. Was the money allocated to you the way it was justified at the time the budget hearings were held?

Secretary BRUCKER. I will have to get that for the record. I will have to check that, Congressman Ford.

Mr. FORD. It is a little complicated by the fact that the budget request itself was predicated on 360,000?

Secretary BRUCKER. That is right.

Mr. FORD. However, we gave funds for an average strength of 400,000 predicated on figures submitted to the committee on a breakdown basis.

What we ought to have is a comparison of the budget figures as submitted to this committee for its action and the execution of that program for comparison.

Secretary BRUCKER. We will be very glad to get it. I am sure that General Traub can give you a quick statement of that now and then we will supply that for the record later.

(The information referred to may be found above.)

General TRAUB. Mr. Ford, I think the answer as to whether or not the money allocated by Congress was used for the purposes intended can be answered as follows: It was, except for $5.1 million which was used for the civilian pay increase, within the National Guard appropriation.

FINANCIAL ELEMENTS NOT FORESEEN

Mr. FORD. In your supplemental before the Congress currently was there $5 million-plus asked in this category to take care of that deficiency?

General TRAUB. No, sir.

Mr. FORD. The civilian pay increase problem does not interfere with your 400,000 average strength?

General TRAUB. No, sir, except to the extent that we were required to absorb this amount within the total National Guard appropriation.

I am trying to clarify and to be as explicit and as specific as I can as to the use of the money in the National Guard appropriation. One might say that the moneys appropriated by Congress in the National Guard appropriation were used for National Guard activities.

Mr. FORD. If every penny that Congress had appropriated for the 400,000 average strength had been allocated for strength, you would not be here on that problem today; is that right? It cannot help but be, if your figures are accurate.

The only deficiency before us today is on the pay of civilian personnel.

Mr. FINUCANE. Mr. Ford, for years now, we have based our estimates upon experience of drill attendance and reenlistments. Had these estimates been correct, we would have been exactly on target and made the 400,000, and we will still make the 400,000. This $1.1 million that we are noting is only the difference between the man who is enlisted and goes to camp now and the man who is enlisted and goes to camp in fiscal year 1960. So we are still going to make the 400,000.

Mr. FORD. Then there are only three items.

Mr. FINUCANE. There are three items we could not foresee. We are going to be in the same trouble next year. We have more people reenlisting than our experience showed when we made up our program and we have more people attending drill than our experience showed historically when we made our program.

Both of them are a great improvement of our readiness, but both of them cost extra money. The increase in the grade structure of the reenlisted people costs us $8.1 million. The increase in drill attendance costs us $2.4 million. The difference in this is whether we send a thousand. 2,000, or 3,000, to start 6-month training after high school in fiscal 1959 or 1960. If they go on active duty training in fiscal year 1959, the cost is $1.1 million.

Mr. FORD. As I understand it, there are three elements which this committee and the Congress did not foresee.

Mr. FINUCANE. That is correct.

Mr. FORD. Consequently, it did not adequately fund; one, the increased drill paid attendance

Mr. FINUCANE. That is correct.

Mr. FORD. As an unforeseeable factor, it involved how much money?

Mr. FINUCANE. $8.1 million.

Mr. FORD. As that directly relates to the competence of the guard, and I am sure——

Mr. FINUCANE. I beg your pardon. The increased number of people attending drill, did you ask?

Mr. FORD. Yes.

Mr. FINUCANE. That is $2.4 million.

Mr. FORD. That directly relates to the competence of the guard and I doubt if we would want any decrease in that under any circumstances.

Mr. FINUCANE. I agree.

Mr. FORD. Mr. Secretary, the reenlistment rate increase costs how much?

Mr. FINUCANE. $8.1 million.

Mr. FORD. We are all in favor of that. We talk about it a lot and I do not see how we can hesitate to fund for it.

The other item is $5.1 million for civilian pay?

Mr. FINUCANE. No, sir. We have apportioned that.

Mr. FORD. We did not fund for that and that is in this program?

Mr. FINUCANE. That is correct.

Mr. FORD. That does not relate to the 400,000 average strength?

Mr. FINUCANE. None of them do.

Mr. FORD. That $5.1 million has been used for other purposes, the increase of pay which Congress approved?

Mr. FINUCANE. Correct.

Mr. FORD. If we approved that legislation, we ought to reimburse the National Guard fund for that because that was our responsibility, not anybody else's? However, I believe the Army Guard could absorb that amount.

Mr. FINUCANE. It was not provided for in the appropriation.

One other point which should be included in your line of questioning is the $1.6 million needed for speeding up the National Guard takeover of NIKE sites, which again is a wonderful program I am sure we are all in accord with——

Mr. FORD. Of course, that was something that could have been forecast by the Army, and the Department of Defense, at the time the budget was submitted?

Mr. FINUCANE. I think we underestimated in all four categories myself.

Mr. SIKES. Now may I request——

Secretary BRUCKER. On that last item, I would like to say this: It is a question of whether we could have forecast it any more accurately than was done as to the takeover of the NIKE. We have been trying to accelerate that program. If we have gone a little too fast in doing it, it is only in the interest of national defense and to get the Guard in there

Mr. SIKES. There are four items in which there is a deficiency. Mr. Secretary, you listed them, or Secretary McElroy listed them, as A, B, C, and D.

I would like these to be listed in the record with your statement showing the effect of each of those shortages on the National Guard program if the money is not provided.

That can be submitted for the record.

Secretary BRUCKER. Yes, sir.

Mr. SIKES. Or any of these four alternative situations.

Secretary BRUCKER. Yes, sir.

(The material referred to follows:)

STATEMENT OF UNFORESEEN FINANCIAL REQUIREMENTS FISCAL YEAR 1959 AND IMPACT IF ADDITIONAL FUNDS NOT RECEIVED

A. Pay of Army National Guard military personnel has increased because of a higher pay grade structure caused partly by improved reenlistments for an amount of $8.1 million.

Impact.—Deferral of critical logistical support to Army National Guard, such as—

(1) Deferral of shipments of excesses to depots and lateral distribution of supplies and equipment between States.

(2) Deferral of the purchase of badly needed tool sets and test sets for new equipment, and replacement parachutes, tentage, et cetera.

(3) Cancellation of armory drills.

B. Attendance at paid drills increased 2.5 percent creating an additional cost of $2.4 million.

Impact.—Cancellation of armory drills.

C. The Army National Guard air defense program was accelerated in conjunction with the total air defense program, with increased costs of $1.6 million.

Impact.—Deferral of the purchase of badly needed tool sets and test sets for new equipment, and replacement parachutes, tentage, et cetera.

D. Reinstatement of the requirement for 6-month trainees $1.1 million.

Impact.—Will not provide sufficient input of 6-month trainees in support of the congressionally prescribed strength.

EFFECT ON GUARD IF FUNDS ARE NOT MADE AVAILABLE

Mr. SIKES. Would you say that each of the four alternative situations are undesirable? In other words, would each of these shortages have a damaging effect on the National Guard program if they were allowed to continue?

Secretary BRUCKER. I would say that each of them, or a combination of any of them, would have very unfortunate results.

Mr. SIKES. There is a question about the way in which this money should be provided, if the Congress should decide to provide it.

If this money is to be supplied to the Department of Defense, it would almost necessarily have to be in the coming deficiency bill if it is going to reach you in time to be of value in allowing you to program for its utilization; is that correct?

Secretary BRUCKER. Can I answer that further than yes by saying the reason why I say "Yes"?

Mr. SIKES. Of course.

Secretary BRUCKER. I think, in line with what all of you have discussed here, that what you are trying to do is to consider carrying out the intent of Congress in the 400,000 figure. I want to work in that direction and have been directed to do so by the Department of Defense. It is our desire to do it. If we are going to do that, the only way we can do it is to have it done promptly, now. I must take action on this thing within the next 7 to 10 days unless we get some assurance that you do not want it done. It is only fair to the Chief of the National Guard Bureau who has to take the responsibility of the criminal statute of the Congress in not carrying out his duty, that I authorize him to send telegrams or some word of some kind by April 1 so that the men in the field may know the extent and scope of their responsibility and what they must do or not do.

I would feel derelict in my duty if I did not have some answer to this thing one way or another. I will have to send guidance out or order it to be sent out very, very shortly.

OBLIGATIONS AND EXPENDITURES

Mr. MAHON. Mr. Secretary, will you place in the record and make available to us this afternoon, if you can, your obligational figures with respect to the various categories? That is, exactly where you are with respect to expenditures and obligations?

I assume that these are the figures which have led you to make the statements and form the conclusions which you have expressed here.

Secretary BRUCKER. We have them right here.

The schedule is made up now.

(The material referred to follows:)

Obligation and requirement schedule

[Dollars in thousands]

	Program and description	Obligations Jan. 31, 1959 (actual)	Obligations Mar. 31, 1959 (estimated)	Obligations June 30, 1959 (estimated)	Additional Requirements	Revised funding requirements
7000	Military personnel costs	$122,424	$150,000	$207,454	$11,600	$219,054
	Annual active duty for training-P/A	27,483	27,900	[1] 38,741	[2] 900	39,641
	Pay during drills	58,078	74,900	[3] 95,789	[4] 9,600	105,389
	6-month Federal status program	23,656	31,100	[5] 46,040	[6] 1,100	47,140
	Others	13,207	16,100	26,884		26,884
7100	Command and management	997	1,200	1,560		1,560
7200	Training	980	1,250	2,519		2,519
7300	Materiel	2,277	2,900	6,400		6,400
7400	Supplies and repair parts	8,177	10,000	14,050		14,050
7500	Services including equipment maintenance	59,035	76,200	102,310		102,310
7600	Antiaircraft defense	5,459	7,200	[7] 8,600	[8] 1,600	10,200
	Total obligations (includes reimbursement)	199,349	248,750	342,893	13,200	356,093
	Appropriation			342,093	13,200	355,293

[1] Limits participation in annual active duty for training in 4th quarter (within end strength of 400,000).
[2] Provides for the revised rate of pay based upon obligations reported for training consummated in the first half of fiscal 1959.
[3] Limits participation to 44 armory drills, a reduction of 4 drills below the 48 programed.
[4] Provides for 48 armory drills.
[5] Limits the 6-month training input to 52,100 trainees and necessitates deferment of an additional 2,900 to fiscal year 1960 to meet the end strength of 400,000.
[6] Provides for a 55,000 trainee input.
[7] Limits acceleration of NIKE program and will support but 1,650 man-years of an 1,816 program.
[8] Provides for the revised technician structure and program changes approved by the Department of the Army.

FAILURE OF DEFENSE DEPARTMENT TO REQUEST REQUIRED FUNDS

Mr. MAHON. All right. We are going to have the deficiency bill before the full committee tomorrow.

Secretary BRUCKER. Would you tolerate my saying something here?

I want to add to what I previously said.

In my previous reply, I did not want it in any sense to appear that I am endeavoring to say that, right or wrong, I am going to send out some messages. If I know it is the will of the committee to take action upon the matter by giving some supplemental funds, then most certainly I would be encouraged to the point where I would not feel I was violating the law or my duty to withhold any action until such time as the Congress decided what it wants to do.

Mr. MAHON. The adjutants general of the various States have already been notified of the difficulty. They have wired and called members of this committee.

Secretary BRUCKER. They have not been officially notified that they are to cancel drills. That is a final act.

Mr. MAHON. You are correct.

As I said earlier, I am going to check my remarks and my phraseology, but I do not quite understand how men of good will and good judgment can come before us on this problem without saying forthrightly what they want Congress to do. It is up to you to administer the Department of Defense and the failure to request needed

funds is being ascribed to the fact that this was not recommended by the Department of Defense in the first place.

Secretary BRUCKER. Mr. Chairman, I do not think Secretary Finucane has the authority to do more than he said. I think he said just as much as he can.

Mr. MAHON. I agree with that thought. The question is, Does the Department of Defense feel that, in view of all of the circumstances, including the law and the place we find ourselves in at the moment, the funds should be provided by Congress?

Yet, this is not sufficient anxiety and determination to maintain the power and strength of the National Guard at this critical moment in world history, to speak up and say as men of good will who are interested in the welfare of this country and national defense, "Yes, we didn't like that program and we didn't recommend it, but under the circumstances at this moment, we think you ought to provide the money."

It is clear that without the funds in question the readiness of a part of our ready defense force will deteriorate, and at a time of great international tension.

Off the record.

(Discussion off the record.)

POSSIBLE TRANSFER FROM ARMY O. & M.

Mr. MAHON. Why in the O. & M. figures for the Army, General Traub, can you not provide funds to meet part of this deficit? You have considerable leeway under the language of the law.

General TRAUB. Mr. Chairman, we are woefully short in O. & M., as you know.

Mr. MAHON. The total O. & M. for the Army is how much?

General TRAUB. We are already in for a supplemental appropriation.

Mr. MAHON. How much is it, over $3 billion?

General TRAUB. The total O. & M. appropriation is a little over $3 billion. We have already come in for a deficiency appropriation of $42.4 million.

Mr. MAHON. I wanted to get that in the record because with foresight in planning it might have been possible to shade things a little and on some other programs, and to have taken care of this thing.

General TRAUB. I would answer that for the O. & M. appropriation during the year we have been on a most austere basis, and not only are we on an austere basis but we were going into a deficit position. This has resulted in our budget request for an additional $42.4 million in order to get us through fiscal year 1959.

Under the circumstances, it may be concluded that there are no extra funds in the O. & M. appropriation.

Mr. FORD. May I ask a question at this point?

Mr. MAHON. Yes.

COST OF CIVILIAN PAY INCREASE

Mr. FORD. Am I right that in the National Guard civilian pay area, there is how much money involved because of the pay increase law that Congress enacted?

Mr. FINUCANE. $5.1 million.

General TRAUB. $5.1 million was utilized in the appropriation of the moneys that Congress appropriated for the increased strength of the National Guard. That much was devoted to civilian pay increases. I have been informed also that the $5.1 million figure is the figure for the total amount involved in the civilian pay increase.

Mr. FORD. Will you repeat that?

General TRAUB. The $5.1 million is the total amount involved in the National Guard appropriation for the civilian pay increase.

Mr. FORD. Against a total pay for the civilians in the National Guard account?

General TRAUB. Perhaps we can supply that for the record, sir.

(The information referred to follows:)

The total civilian pay of the Army National Guard is $96,521,000 which does not include FICA or retirement funds.

Mr. FORD. That was based on the law which Congress passed in the last session?

General TRAUB. Yes, sir.

Mr. FORD. Of course, it could not be foreseen in the budget for fiscal year 1959 at the time that that law was enacted?

General TRAUB. That is correct.

Mr. FORD. In the deficiency which was requested for pay to meet the needs of this pay increase legislation, was there anything requested for the National Guard portion?

General TRAUB. No, sir.

Mr. FORD. How much was requested by the Department of the Army for the civilian pay increase?

General TRAUB. The total in the supplemental appropriation for the cost of Lebanon and the cost of the civilian pay increase was $42.4 million in the operation and maintenance appropriation, and $9 million in the research and development appropriation for a total of $51 million.

Mr. FORD. How much of that was predicated upon the law that Congress passed for the increased civilian pay raise?

General TRAUB. All except $25 million in the operation and maintenance appropriation. The $25 million is assessed against the emergency in the Middle East.

Mr. FORD. What is the amount?

General TRAUB. $17 million and $9 million would be a total of $26 million.

Mr. FORD. That is all, Mr. Chairman.

Mr. SIKES. Mr. Laird?

REQUEST FOR FUNDS BY DEPARTMENT OF THE ARMY

Mr. LAIRD. I have been in and out of the committee room because of the rollcalls on the floor of the House, but it is not clear in my mind when the Department of the Army made the request for these funds to the Department of Defense.

Was it at the time the deficiency bill was being prepared?

Secretary BRUCKER. On February 12, 1959.

Mr. LAIRD. The deficiency was already before Congress at that time. Could you not tell that you would have a deficiency before that time?

Secretary BRUCKER. That is the date when the request was made. That was the time when it was determined what would occur and what we had. We wanted to have that information go to the Department of Defense and we made the recommendation.

Mr. LAIRD. You were asked to have your deficiency requests in by a certain date and the Department of Army was given instructions through the Department of Defense from the Bureau of the Budget to have their requests for deficiencies in by a certain date; is that correct?

Secretary BRUCKER. I do not know about the date.

It was X date, whatever it was. I do not know when that was.

Mr. LAIRD. It was impossible to tell this until the 12th of February?

Secretary BRUCKER. The magnitude of it was determined as of that date, February 12, when I sent the communication to the Department of Defense.

Mr. LAIRD. Is that the reason there is no formal request before us, because it did not come in in time?

Secretary BRUCKER. I do not know anything about that, sir, because that goes to Defense. I do not like to refer to Secretary Finucane here, but he represents Defense on it and he could speak as to what their reason was.

Mr. LAIRD. Their reason, of course, is that they had already submitted their request for deficiencies for 1959 by the time you had determined there would be a deficiency; is that correct?

Secretary BRUCKER. I would have to inquire here to find out the answer to that. I have before me here the chronology of the Army part in this matter but I do not have the chronology of the other.

Mr. LAIRD. It would seem to me that the Department of the Army on the pay of civilian personnel, required by the Pay Act, certainly could have had an estimate ready in time to be considered with all of the other deficiencies for 1959.

Secretary BRUCKER. The civilian pay increase of $5.1 million was not a part of the deficiency bill referred to because we were required to absorb it within the total National Guard appropriation.

Mr. LAIRD. You did not make your request until sometime on or after the 12th of February?

Secretary BRUCKER. That was when the formal request went in, that is on the National Guard.

Mr. LAIRD. That is all.

Mr. SIKES. Mr. Weaver?

Mr. FORD. May I ask a question?

Mr. SIKES. Yes.

CONSIDERATION OF REQUEST BY DEFENSE DEPARTMENT TO BUDGET BUREAU

Mr. FORD. Did the Department of Defense ever, after February 12, when the Department of Army made its request, submit a proposal to the Bureau of the Budget for this item?

Mr. FINUCANE. We did not submit a request to the Bureau of the Budget for a supplemental.

Mr. FORD. When was your other supplemental request, or deficiency, sent to the Bureau of the Budget?

Mr. FINUCANE. I regret very much, Mr. Ford, that I work in the personnel area now and none of these papers mentioned here have come to me. If you will ask Mr. Cooper here, he will answer those questions definitely.

General MOORE. Representatives of the Bureau of the Budget have studied this matter with representatives of the Department of Defense. It was not sent in a formal manner requesting submission of a supplemental estimate.

Mr. MAHON. Off the record.

(Discussion off the record.)

General MOORE. I might clear the record just a little bit on this item.

You are talking about the items which were submitted for all appropriations to cover certain deficiencies caused by the pay increases?

Mr. LAIRD. It was my understanding that instructions went out to all Departments from the Bureau of the Budget to have their deficiencies for 1959 in the hands of the Bureau of the Budget on or before the 13th of December. I may have to correct that date.

General MOORE. That is correct.

I am advised—and please correct me if I am wrong—that this situation was not clearly in mind at that time, that there were developments in this National Guard matter which were not known then and we had not projected requirements far enough to warrant inclusion merely for that purpose at that time.

AWARENESS OF NEED FOR FUNDS

Mr. FORD. I can believe that is true for most items, but I cannot believe it is true and accurate as far as civilian pay increases are concerned. I have seen no evidence which would convince me otherwise.

General MOORE. I am advised that the projections—and I do not know how carefully they were made—indicated at that time that the $5 million could be absorbed and still comply with the mandate. Maybe Mr. Finucane can throw some light on that.

Mr. FINUCANE. That statement is in the Secretary's letter.

This might help a little bit: When it was considered that the $5.1 million should be absorbed, it was felt that the Guard itself would require fewer people to be trained than had been originally projected. In other words, we hoped to get more of the 2-year men leaving the Active Army into the guard. It so happens that the projection was correct as far as the reenlistments were concerned. We did have 11,000 fewer losses in the first half of fiscal year 1959. But we lost the 11,000 within the same 6 months by a falldown in the number of 2-year obligors joining the guard. So we in essence have had to do as the Secretary stated, increase the enlistments of 6-month trainees. I do not profess to say that that covers the whole $13.2 million. I do not think it does. As I say, I am not in the financial area here.

Mr. FORD. I only say again that I cannot understand how there was not an awareness that you would need $5.1 million for civilian pay increases when the law was passed by Congress over a year ago. If there is any evidence to the contrary, I would like to see it.

DEFENSE DEPARTMENT NOT REQUESTING FUNDS

Mr. WEAVER. I had to leave to vote, and I have not been here to follow all the testimony, but it would seem to me that the tone of the letter from the Secretary of Defense is in pretty strong language and that they do want the money. Is that correct?

Mr. FINUCANE. We are not going to ask the Congress for supplemental appropriations.

Mr. WEAVER. They seem to say if they do not get it, they will have to do this and do that.

Mr. FINUCANE. That is one of the actions we propose to take.

Mr. WEAVER. What do you think about that, Secretary Brucker?

Secretary BRUCKER. I think Secretary Finucane answered the question before, while you were out.

Mr. MAHON. While he was out answering the rollcall.

Secretary BRUCKER. When you were out answering the rollcall, as I should have said for the record there, Secretary Finucane said he was not authorized to advance beyond the import of the letter to say that, that his instructions and all that he was instructed——

Mr. FINUCANE. I did not say that I could not.

Secretary BRUCKER. I would not presume to quote him, and he is here.

Mr. WEAVER. But you would like to have the money, from what I understood you to say. The Defense Department would like to have the money.

Mr. FINUCANE. I would put it another way. Personally, I think it would be too bad if we have to call off these four drills.

Mr. WEAVER. That is all I have.

Mr. MAHON. Mr. Thomas.

ACCURACY OF ESTIMATE

Mr. THOMAS. Mr. Chairman, I do not want to belabor the point. Is this record clear as to where your breakdown of $342 million plus the $13.2 million is going and how much guesswork is in the estimate? How much guesswork is involved in this estimate, Mr. Secretary? What part of this $13 million is just to increase your strength from 360,000 up to 400,000?

Secretary BRUCKER. Answering your two questions, first I think all of the guesswork is eliminated from this problem now. We will get the 400,000 if we get the amount we have stated here.

PRESENT STRENGTH

Mr. THOMAS. Do you have the 400,000 total strength now?

Secretary BRUCKER. No; we do not.

Mr. THOMAS. How many do you have now as of today or the nearest date that you have, Mr. Secretary?

Secretary BRUCKER. 391,000, General McGowan informs me, at the moment.

Mr. THOMAS. 391,000 now?

Secretary BRUCKER. That is right.

Mr. THOMAS. What strength did you have 60 days ago, General?

General MCGOWAN. The guard has always been able to meet any goal in that line where the money has been provided, sir. I think the

Secretary is saying that the guard will carry out the will of Congress if the money is provided.

Mr. MAHON. You did not answer the question, General.

General MCGOWAN. I endeavored to. I am sorry.

Secretary BRUCKER. The question he asked you, General McGowan, was: What was the strength of the guard 60 days ago? Is that correct?

Mr. THOMAS. Yes.

General MCGOWAN. I am sorry, I did not hear that. It was $319,968 on 31 January.

Mr. THOMAS. It was more 60 days ago than it is now?

General MCGOWAN. That is correct.

Secretary BRUCKER. May I answer the second part of the question that you asked, sir?

Mr. THOMAS. Go ahead.

Secretary BRUCKER. There isn't any question in the estimate, either, about the balance of the matter here, because from the number of reenlistments, and particularly in the higher grades, we can now predict as accurately as possible what it will be—as accurately as it is humanly possible—for the fourth quarter. We know we will have improved attendance at weekly drills. We know attendance always increases as it gets toward the summer camp time. We have a factor that we use. This increase or improvement of attendance at weekly drills has now gotten to the point that it is not a rough estimate, but is pretty accurate.

OPERATION AND MAINTENANCE FUNDS INVOLVED

Mr. THOMAS. Mr. Secretary, is there any operation and maintenance money in this request at all?

Secretary BRUCKER. There are no operation and maintenance funds involved here except the $1.6 million for the increased NIKE program. However, if we do not get the money certain logistic support items will have to be deferred.

Mr. THOMAS. That is what prompts my question. In case you get this money, how much of it will you spend for operation and maintenance.

Secretary BRUCKER. With the exception of the $1.6 million for NIKE, we will spend for logistical support $2.9 million in the fourth quarter, which we would have to defer otherwise.

EFFECT OF APPROPRIATION OF LESSER AMOUNT

Mr. THOMAS. If you take this fund, could you get by without crippling any of the activities of the guard on $5.5 million or $6 million?

Secretary BRUCKER. We could not, and I would not recommend it. If you are going to leave the amount as it is here, no amount appropriated, then I certainly am going to do the best I can. But I will have to do all of the things that are mentioned here in order to reach that $13.2 million. I would not endeavor to think that I could do more in one of these fields than in another.

In other words, I would not want to cut out more than four drills in order to keep the logistical support in fiscal year 1959.

Mr. THOMAS. You do not miss any drills with your $13.2 million, do you?

Secretary BRUCKER. That is correct, you do not miss any drills.

Mr. THOMAS. But you have operated on fewer than four drills a month.

Secretary BRUCKER. Do you want to speak about that, General McGOWAN?

General MCGOWAN. We have held not less than 48 drills, sir, each year since World War II, with the exception of an occasional unit which in one fiscal year goes to field training in, say, August–September, and in the same fiscal year the following June may again go to field training. For example: 9 company size units were authorized to hold 47 drills in fiscal year 1958. Otherwise every unit held 48 drills.

Mr. THOMAS. No further questions from me, Mr. Chairman. Thank you.

OPERATION AND MAINTENANCE FUNDS

Mr. SIKES. May I ask one or two questions?

Is there a shortage of operation and maintenance funds in connection with this situation?

SECRETARY BRUCKER. No, there is no shortage. You mean in the four items of the higher pay echelon?

General TRAUB. For the record, I believe I answered before that this program of additional trainees will require $3.8 million in regular operation and maintenance, Active Army operation and maintenance.

Mr. MAHON. While you were answering the rollcall, he pointed out that they already have a deficit and have asked for funds supplemental in this area. So they could not absorb it from available funds.

EFFECT ON GUARD IF NO FUNDS ARE MADE AVAILABLE

Mr. SIKES. To go back to the general question, what you have been telling us, as I understood it, is that if Congress does not provide this money, we are confronted with a situation in which there will be an actual deterioration of the guard structure in a very critical period.

Secretary BRUCKER. To the extent that I have testified here we will have to defer logistical support, we will have to defer the six-month trainees, and we will have to cancel the four drills if we do not get it.

(Off the record.)

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION APPROPRIATIONS

HEARINGS

BEFORE THE

SUBCOMMITTEE OF THE COMMITTEE ON APPROPRIATIONS HOUSE OF REPRESENTATIVES

EIGHTY-SIXTH CONGRESS

FIRST SESSION

SUBCOMMITTEE ON INDEPENDENT OFFICES

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DEPOSITED BY THE
UNITED STATES OF AMERICA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION APPROPRIATIONS

WEDNESDAY, APRIL 29, 1959.

REVIEW OF BUDGET AND PROGRAMS

WITNESSES

DR. T. KEITH GLENNAN, ADMINISTRATOR
DR. HUGH L. DRYDEN, DEPUTY ADMINISTRATOR
DR. ABE SILVERSTEIN, DIRECTOR, OFFICE OF SPACE FLIGHT DEVELOPMENT
JAMES P. GLEASON, ASSISTANT ADMINISTRATOR FOR CONGRESSIONAL RELATIONS
IRA ABBOTT, DEPUTY DIRECTOR, OFFICE OF AERONAUTICAL AND SPACE RESEARCH
ALBERT F. SIEPERT, DIRECTOR, OFFICE OF BUSINESS ADMINISTRATION
RALPH E. ULMER, BUDGET OFFICER
D. D. WYATT, ASSISTANT DIRECTOR, OFFICE OF SPACE FLIGHT DEVELOPMENT
ROBERT G. NUNN, JR., ASSISTANT GENERAL COUNSEL

Mr. THOMAS. Gentlemen, will the committee please come to order?

We have with us this morning the National Aeronautics and Space Administration, and we have a lot of our distinguished and old friends here with us. It is nice to have the Administrator, Dr. Glennan, who is well and favorably known to this committee. He used to be a member of the Atomic Energy Commission.

Here is our distinguished friend of many years standing, Dr. Hugh Dryden, who of course is not only an able scientist in his own right but one of the top Government administrators in anyone's book.

Then we have Dr. Abe Silverstein, Director of Space Flight Development. Doctor, it is nice to have you aboard.

Sometime I wish you would take about 5 minutes off and tell us the difference between the act you are now operating under and the old NACA Act. Can you do that for us?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. We will call on you and give you about 5 minutes, and you ought to be able to do that in 5 minutes.

Then we have Dr. Wyatt, or am I promoting him? He is Assistant Director of Space Flight Development. Are you not a doctor yet?

Mr. WYATT. No, sir; it is mister.

Mr. THOMAS. We will certainly promote you and make a doctor out of you. We might make you a professor.

Then we have Dr. Homer Newell. We are glad to have our old partner back with us again. It is nice to see you, Doctor.

Dr. NEWELL. Thank you.

Mr. THOMAS. How is everything?

Dr. NEWELL. Very well; thank you.

Mr. THOMAS. Where is Mr. Abbott?

Mr. ABBOTT. Right here, sir.

Mr. THOMAS. You look good, and it is certainly nice to have you with us again.

We miss Dr. Rothrock. Is he still out at the laboratory in Cleveland?

Dr. GLENNAN. No, sir; he is here in Washington working with Dr. Stewart in the advanced planning.

Mr. THOMAS. When did you move him up here? Recently?

Dr. DRYDEN. He has been here for about a year.

Mr. THOMAS. That is right. Who is running the laboratory at Cleveland now?

Dr. DRYDEN. Ray Sharp.

Mr. THOMAS. He is a great American. Where is Dr. DeFrance? Is he still in California?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. Then we are glad to have with us Mr. Gleason who is the Assistant Administrator for Congressional Relations. Where is Mr. Gleason?

Mr. GLEASON. Right here, sir.

Mr. THOMAS. You are getting better looking every day.

Here is Brother Ulmer, the budget officer. You cannot get along with him or without him.

Ralph, it is nice to have you with us again.

Dr. Glennan, you have two or three other distinguished gentlemen, and let's put them in the record with their titles.

Dr. GLENNAN. We will do that, sir.

Mr. THOMAS. It is nice to have you. You have some tremendously important business. Let us all do a little talking and see if we cannot work this thing out to the good of the country and the satisfaction of everyone concerned.

Dr. Glennan, perhaps you will want to run your own show. Whichever way you want to handle it will suit us fine. If you want to talk to us or if you want your staff members to do the talking, it is all right with us.

Off the record.

(Discussion off the record.)

Mr. THOMAS. Doctor, you may proceed in your own way.

GENERAL STATEMENT

Dr. GLENNAN. Mr. Chairman and members of the committee, I have a brief statement that I would like to read for the record, and then I will ask other members of the staff to detail for you the major programs which we are to undertake under the request we are making.

Mr. THOMAS. Very well.

Dr. GLENNAN. I want to thank you for this opportunity to present NASA's $45 million supplemental request as contained in House Document 114 to the fiscal 1959 budget of $335,719,532—$154,619,532

of which represents transferred program funds from the Department of Defense—and our $485,300,000 budget request for fiscal 1960.

(The budget request for 1960 as contained in House Document 173, together with the budget tables thereon, may be found on pages 237, et seq.)

I know the National Advisory Committee for Aeronautics, the nucleus upon which we have been rapidly building since October, enjoyed the most cordial, cooperative relationship with this subcommittee. I assure you that NASA will strive for the same type of relationship.

I might add at this point that I am exceedingly proud and pleased to be associated with this fine group of people which has made up the base on which we are erecting this new program, the NACA people.

Because of the great amount of detail involved in these two budget requests, I would like to get right down to a brief review of them. We have our scientists and technical specialists here to provide you with a close look at our program.

The requests we have submitted are essential to U.S. superiority in space exploration and will permit us to carry out our space mission with utmost dispatch.

MISSION OF THE NASA

The mission is a big one. As you know, the National Aeronautics and Space Act of 1958 gives NASA direction over all U.S. aeronautical and space research and development apart from strictly military projects which are the purview of the Department of Defense. But even in the defense area we have an important role: the act wisely requires that we cooperate closely with the armed services and make available to them all developments of military interest. Our relationships with the military have been, and will continue to be, friendly and cooperative. NASA scientists and engineers, for example, continue to contribute significantly to the development of just about every missile in our arsenal. We, in turn, are receiving great assistance from the military on numerous programs, Project MERCURY, the manned satellite program, being an excellent example.

SUPPLEMENTAL ESTIMATES FOR 1959

To get down to specifics on the 1959 supplemental:

To date, NASA has operated with a budget of nearly $336 million for fiscal 1959. It should be remembered, however, that of this $336 million about $100 million represented the continuing cost of the NACA laboratories, $154 million represented amounts transferred from other agencies for carrying on programs which they had begun. The remaining $80 million was the amount which NASA could use to develop and round out the national program, including the initiation of Project MERCURY. We are now requesting a $45 million supplemental to that budget. An additional fiscal year 1959 supplemental estimate of $3,354,000, to cover classified pay costs arising from enactment of Public Law 85–462 is currently pending before the Congress in H.R. 5916.

Mr. THOMAS. You mean you did not absorb any of that, Doctor?

Dr. GLENNAN. It was very difficult for us to absorb an amount such as this increase when we are attempting to build a new organization and a substantially larger organization.

This supplemental consists of the following items: $20,750,000 for research and development in connection with Project MERCURY, the manned satellite program; $12,050,000 for new tracking stations and equipment here and abroad; $9 million for improvement of facilities at NASA's Jet Propulsion Laboratory in Pasadena, Calif.; and $3,200,000, for propulsion development facilities for testing the 1- to 1½-million pound thrust, single chamber rocket engine.

PROJECT MERCURY

Concerning Project MERCURY:

It is evident that we cannot expect to exploit the full potential of space until we get men out there with scientific instrumentation. To accomplish this, we have embarked upon an extensive, step-by-step program of research and development.

The seven astronauts, as you know, have been chosen after exhaustive testing. We are determined that when one of these young men steps into our space capsule for the first orbital flight, he will be facing substantially no more risks than he has been accustomed to as a test pilot.

The Project MERCURY request breaks down as follows: $16 million for rocket boosters; $4 million for development of space capsules; $500,000 for flight simulators and other equipment connected with human behavior studies of the astronauts; $200,000 for data acquisition equipment; and $50,000 for supplies, equipment, alterations, and repairs.

NEW TRACKING STATIONS AND EQUIPMENT

The second item in the supplemental—$12,050,000—will provide new tracking stations and equipment for following earth and manned satellites as well as space probes.

To increase the efficiency of the Minitrack network established for satellite tracking during the International Geophysical Year, we need to build four new stations in Alaska, North Dakota, Newfoundland and an as-yet-undesignated location in Europe, along with new equipment for existing stations.

In connection with Project MERCURY, we must have considerable precision radar equipment which requires long leadtime for delivery. The tracking item will provide precision radar and associated systems in Bermuda, Hawaii, and in southern Texas.

The Hawaiian station, in addition to tracking our manned satellite during the reentry phase, will also control the timing of the capsule's retrorocket.

In the space tracking realm, we have a critical need for long distance tracking stations around the world. One such station has been in operation for some time—the 85-foot diameter antenna at Goldstone near Camp Irwin, Calif. To complete the network, we are requesting funds to establish two more stations, one in Australia, one in the Union of South Africa.

Mr. THOMAS. Were not the existing ones built by the IGY people?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. How many were there?

Dr. NEWELL. There were 10 or 11 of the radio stations and about a dozen of the optical stations.

Dr. GLENNAN. I thought you were speaking about the 85-foot diameter antenna. This was done by the IGY on the space probe actually that Huntsville sent out.

Mr. THOMAS. Off the record.

(Discussion off the record.)

MODERNIZATION OF JET PROPULSION LABORATORY, PASADENA, CALIF.

Dr. GLENNAN. The third item is $9 million for modernization of the Jet Propulsion Laboratory of California Institute of Technology which was transferred to NASA from the Department of the Army on December 3, 1958.

JPL has made an outstanding research and development record over the years in many phases of the missile, satellite, and space probe fields. We are relying heavily upon this installation. However, the laboratory was established before safety codes for liquid and solid propellants were set up. As a result, subsequent safety codes have rendered most of its rocket test facilities obsolete from the safety standpoint.

We are asking $375,000 for land acquisition; $2,775,200 for relocation of area utilities; $1,931,800 for relocation of test facilities; $2,255,000 for modernization of existing supporting facilities; $1,488,000 for new buildings and equipment plus $175,000 for a new electrical substation to provide power for proposed facilities.

EXPANSION OF TESTING FACILITIES FOR SINGLE CHAMBER ROCKET ENGINE

The fourth and last item, $3,200,000, is for expanded testing facilities for the 1- to 1½-million pound thrust, single chamber rocket engine.

In this regard, we have been able to make use of existing Air Force test stands at Edwards Air Force Base, Calif., at considerable saving. However, if we are to meet our 4-year deadline on this engine, which is needed to carry heavy payloads into satellite orbits and deep space probe trajectories, we will have to erect additional facilities at Edwards for individual work on thrust chambers, turbopumps and so forth.

BUDGET REQUEST FOR 1960

Our budget requirements for fiscal 1960, NASA's first full year of operation, total $485,300,000, an increase of $101,226,468 over the amount available for fiscal 1969, including the 1959 supplemental requests.

The 1960 budget request consists of the following: $94,430,000 for salaries and expenses, $333,070,000 for research and development, and $57,800,000 for construction and equipment.

SALARIES AND EXPENSES

The salaries and expenses item provides salaries for all NASA employees with the necessary supporting programs.

(Contractual services for repairs, alterations, minor construction, supplies, materials and equipment are funded under the research and development appropriation.)

Mr. THOMAS. Let us get our budget people and have them to get the pencils out and to be able to break down that $333 million, which you did not do in your justification.

We want to know where, why and how much, and a few other adjectives in addition to your $94 million for your personnel costs.

The first big classification you should break down is personnel, the location, and then your supplies and equipment, and so forth.

STAFFING OF BELTSVILLE SPACE CENTER

Dr. GLENNAN. The salaries and expenses item will provide for 9,988 employees by the end of fiscal 1960, an increase of 1,027 employees over fiscal 1959. Seven hundred and twenty of this number are required to continue staffing the Beltsville space center, now under construction in Maryland.

Mr. THOMAS. What authority did you have to establish that?

Dr. GLENNAN. The authority was granted by the Congress.

Mr. THOMAS. The Senate committee told you not to start it. This committee has never passed on one item of it.

Dr. GLENNAN. I would ask Dr. Dryden who was here at those hearings to speak to that.

Dr. DRYDEN. The Senate committee reduced it.

Mr. THOMAS. This committee never passed on it. I went to conference and handled it in conference.

Off the record.

(Discussion off the record.)

Dr. GLENNAN. Here is the act, Public Law 85–657, which authorizes the Space Projects Center in the vicinity of Washington, D.C.

Mr. THOMAS. I handled the request for funds in conference between the House and Senate, and I repeat that it was never submitted to us.

Dr. DRYDEN. May I review the situation, Mr. Thomas?

Mr. THOMAS. Surely.

Dr. DRYDEN. As you recall, the National Aeronautics and Space Administration was set up rather late in the session. The authorization act for the sum of $125 million was passed. Because it was very late in the session, the appropriation was submitted directly to the Senate on the last supplemental bill going through. There were hearings held by the Senate Appropriations Committee and the Senate committee made the report to which you referred, reducing the amount by $50 million and suggesting that the construction of the Space Projects Center should be deferred. Senator Johnson, the majority leader, defended the original estimate on the floor of the Senate, and made an amendment to restore the full amount of the authorization. He specifically mentioned the Space Projects Center in his discussion on the floor of the Senate and stated that he had asked this agency to proceed with all urgency, that their plans were made, and that he did not think we should wait for 6 months.

The Senate then restored the full amount of the appropriation.

MR. THOMAS. And what did we do in conference?

Dr. DRYDEN. This went to conference and the conferees cut the amount by $45 million with no instructions as to the way in which this cut was to be made.

Mr. THOMAS. However, the amount approved in conference for construction and equipment was $10 million less than the Senate committee had approved, and the Senate committee had specifically de-

ferred the new facility in recommending $10 million more than the conference agreement.

The estimate was never submitted to us and on that very slim, tenuous authority you embarked upon this project?

Dr. DRYDEN. I think the question was asked at that time as to whether you wanted to hold hearings and you went directly into conference with it before you held hearings.

I believe we offered to hold hearings at the time.

Mr. THOMAS. Anyway, you knew what you were doing. You may proceed.

Dr. GLENNAN. 153 will be recruited for the Wallops Island station; 150 will be needed for NASA's Washington, D.C., headquarters.

No personnel increases are contemplated elsewhere in the NASA organization.

RESEARCH AND DEVELOPMENT

The research and development item of $333,070,000 provides funds for NASA's program involving contracts for scientific and technical studies; prototypes and operational hardware; operations and technical services; and contracts for procurement of all supplies, equipment, repairs, alterations, and minor construction required throughout the entire NASA plant. In all, 26 programs make up our total research and development effort.

CONSTRUCTION AND EQUIPMENT

Finally, in the "Construction and equipment" category we include items of a capital nature whose estimated cost exceeds $250,000. These total $57,800,000.

The major proportion of the $20,800,000 being requested for the Langley, Ames, and Lewis Research Centers and for the high-speed flight station is required for a continuing program of plant modernization.

IMPORTANCE OF RESEARCH AND DEVELOPMENT

Mr. Chairman, I want to take a few minutes more of your valuable time to discuss with you the importance of basic research and the critical competitive position our country finds itself facing today. For the past 100 years our Nation, technologically speaking, has only needed to be "good" in order to be a world leader. Today the level of "good" is no longer good enough. Western technological progress has rapidly moved around the world and yesterday's and today's sins of neglect in the area of basic research will, if not corrected, catch up with us soon. We will have become a second rate nation with a future that is not pleasant to contemplate.

It is imperative that we give strong support to both basic research and applied research and development. The latter are required to keep us strong in the present, and to exploit the potentialities of knowledge already acquired. The former is required to lay the groundwork for our strength in the future. The applied research and development can give us only short-term advantages or defenses. No single engineering accomplishment or group of accomplishments can provide us with a guaranteed long-term security, as the recent history of atomic and hydrogen bombs tells us so plainly.

Adequate support of research implies long term and continuous funding. The bad habit of coming forth with huge sums and crash programs only when outside events generate a hysterical sense of urgency is dangerously irresponsible. Although applied research and development can be done on a rush basis, to do so is uneconomical and wasteful of manpower and resources. Also, the timely meeting of essential deadlines can be assured only by making timely beginnings. In fact, if reliance is placed upon always being able to come through with the answers by means of hurriedly instituted programs, the fatal day will surely come when there is not enough time left to accomplish even the crash programs. As for basic research, we have already emphasized that it cannot be carried out on a crash basis.

Today, when the Russian sputniks and luniks testify to the scientific and engineering capabilities of the Soviet Union, we cannot afford to panic. We must answer the challenge with a sound, well-rounded program of research and engineering that includes an ample basic research effort. At the present time we are not giving enough attention to basic research. We must do more. Let us not be content with a few rush missile programs, which can at best provide us with a temporary advantage. Let us not permit a few engineering successes to soothe our injured pride and lull us again into a false sense of security.

A sound applied research and development program now will provide us with the strength we need to defend ourselves against aggression. Everything we read, and see, and hear about Soviet science indicates that the Communists understand these things, and are strongly supporting basic research. Hence, if we as a nation fail to appreciate the true meaning and importance of basic research, if we fail as a nation to carry on a strong basic research effort, if we fail as a nation to make the necessary sacrifices, we will expose ourselves, not alone to the possibility of weapons superiority in the hands of our potential enemies but equally seriously to the possibility of an economic disaster that will be just as devastating. In this business of basic research, effective leadership can only be provided by a wise and close cooperation between the Congress, the executive branch, and those engaged in the carrying out of effective research. From personal experience, I know that few people in the Congress have recognized this great need and acted on it to the same degree as you have, Mr. Chairman.

By way of conclusion, may I emphasize again that every item in this supplemental to the fiscal 1959 budget, and in this 1960 budget request, is absolutely necessary to us at this stage in our development of a national space program. With these funds we can carry out the tasks the President and the Congress have assigned us.

Now, before moving, Mr. Chairman, into a brief discussion of the major programs which this budget is intended to support, I would like to give you a look at the schedule of firings which is proposed for the next two fiscal years.

DIFFERENCES BETWEEN NACA AND NASA ACTS

Mr. THOMAS. Doctor, before you do that will you explain or have someone on your staff point out the fundamental differences between the old NACA Act and the NASA Act?

Frankly, I have hurriedly again looked over the new NASA Act, and with our former interpretation on the old act could we not do just about everything under the old act that you can do under this new act, with the exception of a few salary items, a few word directions and a few more specific authorizations?

Dr. DRYDEN. May I try to answer that question?

Mr. THOMAS. Whoever wrote the old original act, in putting those words "problems of flight," just about covered the situation. I do not know how you are going to express in three more words any greater authority than that right there.

Dr. DRYDEN. The new agency to which NACA was transferred is a completely new agency with powers and responsibilities that go far beyond those of the old NACA. The old NACA was a research and development organization, carrying out research at laboratories with which most of you are familiar, on the ground and in wind tunnels and in similar ways. We did not design airplanes. We did, however, fly airplanes for research purposes.

The new act passed by the Congress assigned to us two additional responsibilities of a very different character. One was the development of space vehicles.

Mr. THOMAS. Let us see where that is in the act.

What section is that?

Dr. GLENNAN. It is section 102(c)(3), wherein it says:

> The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space.

Mr. THOMAS. Equipments and living organisms through space. You mean an airplane will not do that?

Dr. DRYDEN. It will not. This is a space vehicle. It is a system fully as complicated and expensive as a ballistic missiles system.

Mr. THOMAS. The section states:

> The development and operation of vehicles capable of carrying instruments, equipment, supplies, and living organisms through space.

What specific definition are you putting on the word "space" in order to exclude an airplane from that classification?

Dr. DRYDEN. It does not exclude an airplane but it includes the combination of rockets which send large payloads in space. In other words, we have the mission in this country of developing sputniks corresponding to the Russian sputnik. So we have made a contract——

Mr. THOMAS. That language then puts a new duty on you?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. You may proceed.

Dr. DRYDEN. It is a completely new duty.

The second one is the operation of space vehicles for research purposes such as the EXPLORER and the VANGUARD.

Mr. THOMAS. What section is that contained in?

Dr. DRYDEN. I think the word "operation" is in that same section.

Dr. GLENNAN. "The development and operation * * *."

Dr. DRYDEN. This means that the firings at Canaveral—which temporarily were assigned by the Congress to the Department of Defense before the existence of the National Aeronautics and Space Administration—have been transferred to this new Agency after it was

created; the EXPLORERS and the PIONEERS have become our responsibility. We are responsible for planning and carrying on this kind of a program in continuation, of course, of the IGY program on rockets and satellites; more particularly we are responsible for bringing this Nation into the position of leadership.

Mr. THOMAS. That is not your exclusive business to the exclusion of the military; is it? You have a saving clause in there.

Dr. DRYDEN. The military work will continue to be developed by the military, with the help of the research which we do in our laboratories with which you are familiar. Many of the measurements to be made by instruments in space will be used to support the development of military space vehicles such as reconnaissance satellites and, later on perhaps, satellites for early warning.

CIVILIAN AND MILITARY SPACE ACTIVITIES

Mr. THOMAS. Doctor, let us get down ultimately to the point. What is the conflict, if any, of jurisdiction between this Agency and the military in this particular field?

Dr. DRYDEN. There is no conflict. There is a border area in which there are certain projects that must be very carefully coordinated. For example, in the case of communications satellites, the military is interested in a military communications system with coded responses, secrecy, and communication all over the world. Communications satellites also have civilian applications. In fact, it appears that this will be the earliest practical application of the satellite to a commercial purpose.

Mr. THOMAS. Well, the theory which put one into orbit or puts one into space is the same. You are talking about the difference in purpose.

Dr. GLENNAN. It is the difference in application and use.

Mr. THOMAS. What does the statute say? Is that the distinction betweeen your activity and the military? Of course, where you spend a dollar the military has been spending $50.

Dr. DRYDEN. You are thinking of NACA. It is going to be necessary for this new Agency to spend very large sums if it is going to do the job which the new act of Congress has assigned to us.

Dr. GLENNAN. The Congress, Mr. Chairman, in setting up and passing this act declared the policy of the United States to be that activities in space should be devoted to peaceful purposes and that the activity should be conducted by civilian agencies with the exception that activities peculiar to or primarily associated with the development of weapons systems shall be the responsibility and shall be directed by the Department of Defense.

Mr. THOMAS. That is what I am getting at. In truth and in fact the act itself perhaps unwittingly sets up two competing systems.

Dr. DRYDEN. Not unwittingly. It was decided probably to have a civilian space agency and to have miliatry space applications.

Mr. THOMAS. The research for one will serve both; will it not?

Mr. OSTERTAG. How do you separate the two?

Mr. THOMAS. I am referring to basic research.

Dr. DRYDEN. The whole field of measurements and investigation of the space environment that was begun during the International Geophysical Year is assigned solely to the new Agency. The Department of Defense has no assigned mission to make measurements in space out to the moon and the planets as a preparation for the use of space for both civilian and military purposes. This field is exclusively ours.

The military will be the agency which will develop reconnaissance satellites with all the equipment they contain, with the special provisions that they will need in that type of equipment.

Mr. THOMAS. Your big problem before you is in making your measurements of getting the satellite up in orbit and you have to do a lot of research before you come to the second phase which you are now talking about.

Dr. DRYDEN. At the present time both of us are using ballistic missile boosters, for this reason the costs of the space program appear very much less than they are going to be when we go beyond the use of ATLAS and THOR. We are the beneficiaries of a multibillion-dollar program which has produced very large rockets, which can be combined with upper stage rockets, to give us space vehicles at much less expense; but to go to higher payloads and try to come anywhere near what our competition has put in the sky, will require rockets that go beyond those which have been developed for the military system.

At the present time the development of those new rockets is our responsibility. Certain projects were transferred to us from Defense in this area. For example, the responsibility for the development of a rocket engine with 1 to 1.5 million pounds of thrust was by Executive order transferred to NASA from the Department of Defense. We have initiated a contract with North American with the funds appropriated to NASA during the current year to begin the practical development of this engine. It is a job which will take about 4 or 5 or 6 years to do and it will cost money.

Mr. THOMAS. What will Dr. Von Braun's team in Alabama be doing that is separate and distinct from what your side is doing?

Dr. DRYDEN. He is actually working with and for us under the transfer of funds, and he is firing satellites for us. In fact, this whole expansion or the whole new activity is being carried out mainly by contract with existing organizations and agencies. We are building up the staff only to the point necessary to monitor these contracts.

Dr. THOMAS. Is he under the jurisdiction of the Army or under the jurisdiction of the NASA?

Dr. DRYDEN. He is under the jurisdiction of the Army. We have an agreement with the Army with respect to the use of the facilities at ABMA. We also are using facilities of the Air Force. We have not set up firing teams to fire THORS and ATLASES. We are doing this by contract with the agencies which now do this.

Dr. GLENNAN. May I, Mr. Chairman, attempt one further bit of clarification here?

Mr. THOMAS. Surely.

Dr. GLENNAN. It seems clear to me that we have a responsibility for basic and applied research pretty much across the board, and that what ARPA and the Defense Department will be doing in terms of research will be in applied research which is aimed at the end items which they want to put into operational systems.

Mr. THOMAS. I think we can go with you so far. That covers it. You may proceed.

Dr. GLENNAN. That, I think, gives essentially the facts. In our applied research there must be an interweaving and a degree of coordination which we are in the process of developing. It is not all that it should be as yet. Let us take a communications satellite, for instance, in which they have a very great interest because of the fact that their military communications are getting close to the point of being overloaded. We are also interested in the communication satellites and the development of these techniques and understanding of what can be done with satellites to aid our communications capabilities.

We are dealing with one phases of this at the present time called a "passive satellite" and they are dealing more particularly with an "active satellite" where they carry in the satellite electronic equipment which picks whatever information is given to it and repeats it either at intervals over a particular location or over another piece of land or continuously, as the case may be. In those two programs there are undoubtedly fallouts from their program information which will be very useful to ours, and in just the same way in our program there undoubtedly will be fallout information which will be very useful to theirs. There is really no duplication in that sense.

Dr. DRYDEN. May I cite again to the other members of the committee that may not have had an opportunity to study this act or the legislative history leading up to it; the Congress debated last year whether to create a new agency from scratch—a new civilian agency—or whether to assign all space functions to the military, leaving NACA to do what it had always done; or whether to take some other course of action. I think even at one stage other agencies were considered. Instead of developing a completely new agency, the Congress accepted the recommendation of the President that a civilian agency be created; that it be responsible for the civilian applications; that activities in space be primarily for peaceful purposes; and that the responsibility for military applications be retained in Defense.

We in NACA did not write this bill. It was written in the Congress and the Congress determined that there would be two agencies. They set up the language that you have seen and we have acted as if——

Mr. THOMAS. Off the record.

(Discussion off the record.)

Dr. DRYDEN. I merely want to say that you are not dealing with the old NACA. It was transferred to the new agency.

The new activities have taken a lot of the same people of NACA and assigned them to new duties. We are presenting here, I believe, six presentations, of which one deals with the work formerly done with the NACA, and five deal with the work of this new agency.

We happen to be familiar faces. If Congress had acted otherwise, you might have a completely different group of people talking to you about this same program.

Mr. THOMAS. Do you and Dr. Glennan and your very capable staff here agree with the military that the old airplane is here to stay; that it is getting bigger and better and faster, and that it will be many years, to say the least, before the military can get along without it?

Do you think the B–70 will have a utility when it is completed 4 or 5 or 6 years from now?

Dr. DRYDEN. Yes, sir; we will talk to you about the B–70 in the presentation dealing with the leading phases of our work. We will talk as well on missiles.

Mr. RHODES. Mr. Chairman, may I ask a question?

Mr. THOMAS. As a matter of fact, it is more of a missile than it is an airplane.

Mr. OSTERTAG. That is true of the X–15 also.

Dr. GLENNAN. Yes, sir; we will talk about that also.

Mr. THOMAS. Mr. Rhodes?

NUCLEAR FUELS FOR ROCKETS

Mr. RHODES. In your basic research on this 1.5-million-pound thrust rocket do you get into research on different types of fuels?

Dr. DRYDEN. That rocket is an actual engine development in the same way that the military develops an airplane or a ballistic missile engine.

This is a similar project of developing a piece of hardware to be used in vehicles to be fired into space for various purposes.

Mr. RHODES. What I am really interested in is the research you are doing on the use of nuclear fuels for rockets?

Dr. DRYDEN. We are engaged in a cooperative program with the AEC on nuclear projects.

If I may go back a little, you will recall that there were programs such as ROVER—you have heard the name, I am sure—for the development of a nuclear rocket in the Atomic Energy Commission with the Air Force doing the support, in nonnuclear aspects. The Executive order to which I refer transferred the Air Force's responsibility to NASA so that we this year transferred certain moneys to the AEC for our part of the support of the ROVER project, and we will be engaged in a continuing program with AEC on the application of nuclear energy to space problems.

This will go on from year to year.

There is some money in our budget for that.

Mr. RHODES. Primary responsibility, then, for the development of nuclear fuels is still with the AEC?

Dr. DRYDEN. Yes, sir; for nuclear fuels.

Mr. RHODES. And you are cooperating insofar as the airframe and the aerodynamics and the pumps, for instance, are concerned?

Dr. DRYDEN. And other mechanical equipment; yes, sir.

Dr. GLENNAN. Mr. Chairman, many of these questions will be answered, I think, more fully and be more illuminating in the brief presentations that we have.

Mr. THOMAS. You may proceed.

COORDINATION WITH DEPARTMENT OF DEFENSE

Mr. OSTERTAG. Doctor, the Department of Defense or ARPA is associated in many respects with basic research with respect to space vehicles. You likewise are associated with basic research.

Is there a duplication or coordination that can be applied in connection with that?

Dr. GLENNAN. In the first place, Mr. Ostertag, the basic research which ARPA is supporting is more particularly in the areas of new chemicals and new chemical fuels and that type of thing. The research work they are doing in the space field is largely applied research aimed at particular ends which the Department of Defense wants to attain. These happen to be communcations and early warning, as Dr. Dryden has pointed out, and matters of that kind. Where there is substantial basic research involved, most of this is coming right back to us. The meteorological satellite is a good example. Here we are really just probing into a field which needs a great deal of research and that has now been transferred completely to us.

Mr. OSTERTAG. There is really no duplication of effort?

Dr. GLENNAN. I think it is reasonable to say that there is no duplication of effort. If there is any, it is a very minimum duplication and steps are being taken—have been taken and are being taken—to attempt clearly to avoid this sort of thing.

Dr. DRYDEN. ARPA is not a space agency. ARPA is a management group, managing funds appropriated to the Secretary of Defense for special projects which cut across the three services.

They have responsibility only for the projects assigned to them. They have a responsibility for research on defense——

Mr. OSTERTAG. Let us take the Defense Department as a whole.

Dr. DRYDEN. Considering the Defense Department as a whole, their projects in space include the development of a communications satellite and the development of an early warning system. I do not know whether they are formally adopting a program for something that will shoot down satellites that we do not like over us, but they certainly have talked about such a program. They have a special program to try to develop an improved solid propellant because of their increased use of solid propellants in the ballistic missiles program.

I would say that these programs are coordinated as fully as it is possible to do so. The Defense Department is concerned with military systems for use by the services, and we are concerned with developing the basic information necessary for military systems; at the same time we have a primary mission given to us by the Congress to develop peaceful uses of space, to develop scientific information to use in communications and meteorology, as you shall hear from some of these presentations which will be made today.

Dr. GLENNAN. I wanted, before introducing the other witnesses, to simply point out if I may on this chart the number of firings, the types of vehicles and so forth that we are going to use in the balance of calendar year 1959, calendar year 1960, and hopefully in calendar year 1961.

I would like this to be off the record, if I may.

Mr. THOMAS. You are in charge, Doctor.

Dr. GLENNAN. This is not a classified document but we do not want to tell the world what our firing schedules are. As Dr. Dryden pointed out the other day, the Russians are not telling us what they are doing, and we think this is a very important document and we should not be telling them anything about what we are doing.

Mr. THOMAS. Off the record.

(Discussion off the record.)

PROJECT MERCURY

Dr. GLENNAN. The first of our witnesses is Dr. Dryden on Project MERCURY, and if we might proceed with that, Mr. Chairman, I would point out simply that the total amount to be expended this year, assuming that the 1959 supplemental is approved——

Mr. THOMAS. Is the Doctor speaking now as an administrator or a research scientist? He can wear both hats and, perhaps, three hats. How many hats do you have on this morning, Dr. Dryden?

Dr. DRYDEN. This one is describing some of the technical and administrative aspects of the project.

Project MERCURY is the highest priority project of the new Agency and I am sure it will be worth my while to spend just a moment on why we want to put man into space.

Why do we have this project in existence? It is based upon several elements. One is the very widespread conviction that man will go into space, that he can do useful things there, and it will be necessary for him to do them, and we had better get on with the job before competition does it.

One of the things which would certainly represent an indication of leadership in space technology is to have a man orbit the earth before someone else does it. If someone else does it first, we will be confronted with the same situation that we had with the Sputnik. The unfortunate point is that we cannot guarantee that our competition did not start this 2 years ago. They have the capability and they may be first. All we can do is to lay on a program with the greatest urgency and backing that we can give it.

We feel that the gaining of this technology is an essential element in the leadership in space technology. At the same time, then, it is an element of the cold war.

Mr. THOMAS. Doctor, before you leave that, you made a very positive statement a while ago that man is going to learn some things up there which he can only perform while up there.

You might spell those out for us.

Dr. DRYDEN. I will first give you an analogy. Whether you can make instruments as good as men to do certain jobs is a question which has been debated for the past 10 years. I think Bill Bridgeman has shown one way to say that you cannot make instruments that will do complicated jobs in his book on flying one of the research airplanes. When he got into an unstable oscillation the airplane went out of control; after much maneuvering he found that by moving the controls in a direction opposite to normal he came out of it, while moving them in the normal direction only created more difficulty. It is very difficult to think of any machine that someone could build which could readjust its thinking and its judgment to that situation.

As far as space goes, I have been told by people who have studied the problem that while you can do reconnaissance with unattended instruments, you can do a lot more if you have a man up there who, if he decides wants to look at a small area more intensely, can program the instruments as the area sweeps by and study it more carefully. It is very hard to build into an instrument the capability of stopping and looking at one area intently.

There is also the fact, of course, in missile technology that instrumentation is easy to fool. You can trick it. It is much more susceptible to being tricked. Man has built into his brain judgment which is very hard so far, at least, to duplicate in any computer. You can tell a computer to do a job the way you instruct it, but you cannot tell it to readjust itself to some new situation for which you were not able to give it instructions in advance.

The same is true in scientific application. We are going to have to do a whole lot of experimentation in the space environment if we want to learn how to do space travel.

Some of these problems you may have heard about. For example, in doing experiments in bell or vacuum jars it has been found that in any piece of simple machinery that involves rotation of a shaft or a bearing of any kind, the absence of air will cause those bearings to fix.

If we are really talking about going beyond the moon to the planets, we will have to build mechanisms which will work reliably over a period of a year with no attention. It almost strains the imagination to think we can build anything that does not need an oil can or a screwdriver for a year. We do have a few household appliances that come pretty close to that, but in very complicated machinery and apparatus it is difficult to conceive of this. In fact, some—and I am not included among these proponents—would say that you can do the job just as cheaply in the long run if you start with the idea that you are going to require a man there instead of talking about building an extremely complex computer and gadgetry. I do not know that that is right. I think we have to do both.

In addition this is one way of advancing space technology very rapidly: to learn something about man in his environment.

I mentioned that we put a program on to achieve manned orbital flight in the quickest possible time, using the simplest vehicle and the technology that we have now, and not waiting for any new developments. A great many people have studied this problem, and they come up with the same conclusions.

This project is just a milestone. Some of your colleagues have asked us, "Where does this go?" This is a milestone on the road to manned space flight. It is a long road. We started with the X–15, which is a very remarkable vehicle. It can be fired up to a height of 100 miles by its rocket system, and then come back and reenter the atmosphere, so that the man is in space for about 5 minutes. He has to learn how to control the airplane and get it back into the atmosphere safely.

There will be a further development of this lifting or winged type of vehicle, but it will take longer.

We speak of the vehicle for orbital flight, mainly with reference to data furnishing concepts which means you go beyond this to lifting vehicles; only with lifting vehicles do you obtain maneuverability and control of landing.

Then, as you go down the road, and as the technology develops, you put up several more for several days. You will, perhaps, have a laboratory for long, continuing experimentation which could be carried in the space environment.

There are some military uses for such a thing as well as other types of applications.

There are, of course, the next milestones, so to speak; to send a man to the vicinity of the moon, around it, and back home again in safety; then to manned landings on the moon and return, and down to earth; and then to interplanetary travel of man.

An estimate has been made that if this program is really pushed and if the American people are determined to do this kind of an advance in technology, we might arrive at this general vicinity in something of the order of 10 or 15 years. It will take a lot of money and effort to do that.

VALUE OF PROJECT MERCURY

Mr. THOMAS. What are we going to gain from that effort and that type of imagination?

What are some of the things you can think of?

Dr. DRYDEN. It is difficult to be imaginative enough. You are in the position exactly as if you were sitting over here at Ft. Myer watching Wilbur and Orville Wright in this bit of cloth and wire and wood that you see in the Smithsonian, and someone asked you whether or not it would work. Could you have foreseen the development of the airplane of today and all that has come from it? At that time, as you know, they thought that it might be useful for sport and they thought it might be useful for observation and taking messages in wartime, and that was about the limit of imagination of most of the conservative people.

There are a few wild ones who talked of flights in the air with a great deal of ease, protected from the wind and weather, who foresaw something of transportation; our problem now is to try to foresee this in space.

I guess the greatest writer and thinker on this subject is the creator of the Buck Rogers comic strip. He has done a lot of thinking and speculating about what will come and unfortunately we are the ones who have to make these things come true.

We are a little reticent about going too far in things that go beyond technology.

I mentioned Project MERCURY. The objective is to put a man around the earth two or three times. He might stay up 1.5 hours or 3 hours or, later, 24 hours. That duration of flight avoids a lot of very difficult problems. For example, the low altitude of the orbit avoids the radiation problem. For the short time involved you can use oxygen equipment and carbon dioxide equipment similar to that commonly used in airplanes. You do not have to develop any new items, and you do not have to carry a lot of food and water because of the short time involved.

If you start going to Mars and Venus, you have to have a closed ecological system as some people have called it. From sunlight you have to grow your food right there, and you cannot deliver anything new. You have to live on the oxygen you started with and reproduce it. You have to reproduce water. This is a little objectionable to some people, but, of course, we do this now. It just goes around a longer circuit. It goes into the ocean and up to the clouds, and back down again, but we will have to do it in a very much shorter cycle than that.

In this short-term flight, we hope to study what a good man can do. Is he so frightened that he cannot talk over the telephone to us? Will

he be able to exercise some control over the vehicle? Can we get him to try to do certain simple tasks? Also he will be instrumented to determine his heartbeat, his respiration, and his skin temperature which tells something about fear. He will be instrumented as a specimen, if you like, to measure his reactions in the space environment.

This is what we get out of it, so far as the man is concerned. We get a lot of other knowledge about technology because this thing has to be stabilized and he has to be able to control attitude and other things. So, while we used the simplest approach we could think of, we are not just going to start out some day and fire the man into orbit. We are going to do a tremendous amount of preliminary work trying to anticipate what the problems are and trying to make this no more than the same degree of risk that we have in the X–15 or any new airplane.

The approach was to substitute for the nose cone of a ballistic missile the capsule with a man in it. That is what we mean by a drag vehicle. He will be boosted into orbit with the ATLAS. The ATLAS has a capability of putting little over a ton into orbit and that is just about big enough to do the job with a man.

CAPSULE REENTRY

The method of getting him back is to fire a rocket backward with respect to his motion to slow him up so he begins to spiral in slowly.

Mr. THOMAS. You mean reentry?

Dr. DRYDEN. Yes, sir. We have to protect him during the reentry. The final slowing down is done with parachutes.

We are providing him with an escape system so even if the ATLAS caught fire on the launching pad, he would have means to get out.

Mr. OSTERTAG. What if he is up in outer space?

Dr. DRYDEN. We would bring him back with the retrorocket. Many of you have seen this in the newspapers and in other places. The substitute for the nose cone consists of a pressure vessel which maintains normal atmospheric conditions. He has an oxygen supply, carbon dioxide treatment, temperature control, et cetera. We put him in a pressure suit, as well. This is a double protection. Again speculating, suppose a fire started in this thing up in space. The easiest way to put out the fire is to open up the connection to the outside vacuum; after that, the fire cannot burn. Being in a pressure suit, he can take that step if he has to.

The pressure suit also gives protection if there should be a collision with a meteorite or some such object, although we do not expect that. We are going to every extreme we can in order to make the risk of this as small as possible.

He is in a pressure suit supported on a couch which is molded to his form. It is molded around the central part of his body to give extra support. This is the means of protecting him against acceleration. First, when he is launched off into space, he is pressed down against the seat by the force of many times his weight. The particular position is important, the position of the legs is important; a great deal of work has been done on this by apparatus owned by the Navy at Johnsville.

In reentry the attitude is changed so he comes in with the blunt face and heat shield forward. Again the deceleration when he en-

ters the atmosphere is in the same direction with respect to his body as during the launching.

Several volunteers have been exposed to accelerations of 20 times gravity with this kind of support, without any indication of trouble. In fact, some have gone higher. Twenty is above the acceleration that would be experienced even in this escape maneuver, which is the worst case. If he has to leave the vehicle after it has gotten up a fairly good speed in the atmosphere before he gets too high, the maximum deceleration occurs, and this would protect him against that.

There is a heat shield. The retrorocket is below it. Attitude controls are in the form of jets. Recovery parachutes are stacked here. These are the pieces. This is the escape system I mentioned. There is a sort of pyramidal framework on top with a rocket.

If, for example, there was a fire on the launching pad, this rocket would be fired to take the capsule up into the air, and it would then be recovered using the parachute system in the normal way. A successful test of this system was made on the beach at Wallops Island with the weight of this capsule in ballast 2 weeks ago. This escape system has been going through quite a series of tests. This is a sort of schematic of events which happened in a launch from Cape Canaveral.

The ATLAS is a one and a half stage vehicle. All three of its engines are started on the ground. After a certain amount of fuel is burned and the vehicle is up to a certain speed, the other two engines are dropped and the central engine takes over. When it gets to where the atmosphere is thinned out, this pyramidal framework escape system is discarded. Here is the final orbit injection, capsule separation, and change of attitude, so that the blunt end is first.

When he wants to come down, the retrorockets will fire. This would happen between Hawaii and the west coast in the orbit plan. This chart gives you much too steep an impression. It is really a very flat and gradual reentry into the atmosphere. When he is through with the retrorockets, he discards them, and comes in with the heat shield. There is—not shown here—a small parachute which slows him up, then the large parachute is opened. He lands on water, the capsule floats, with the life system inside, until he is picked up.

There is a second parachute in case of any difficulty with the first, just as most parachute jumpers wear two parachutes.

Mr. OSTERTAG. Is there a gradual change when it goes into orbit from the atmosphere and when it comes back?

Dr. DRYDEN. It comes back in very gradually.

Mr. OSTERTAG. Is the change gradual?

Dr. DRYDEN. Yes.

Mr. YATES. Where will he land? You propose to launch him from Cape Canaveral. Where will he come down?

Dr. DRYDEN. In the water in the Atlantic missile range where there are concentrated a large number of ships and tracking devices. In our tests off Wallops Island we picked this up with a helicopter. In one of these tests a capsule fired a short distance comes back on the beach in 5 minutes.

Mr. YATES. Can you control the flight to that extent?

Dr. DRYDEN. With this simple type of vehicle, the only control over the landing point is the point at which you fire these rockets and the magnitude of their thrust. This means, first of all, in the early

stages we have to have a tracking system with special provisions to make sure he is in orbit. If he does not get into orbit immediately, we want him brought down in the Atlantic, not in the wilds of Africa. If our early computation shows he is not making it, we fire the retro-rockets right away and bring him down into an area in the Atlantic off the coast of Africa where we have stationed ships.

Someone asked, "What if he gets in trouble on the way around?" You get to him a lot quicker by bringing him down in your prepared landing area after another hour than you would if you landed him off in the middle of the Pacific where it might take days to get to him. Recovery operations are planned primarily in the Atlantic Missile Range area. If he does not get into orbit, we have a secondary station. As he comes around over Hawaii, we have to——

Mr. YATES. How are you able to tell whether he is conscious or not, by respiration or other tests?

Dr. DRYDEN. By telemetered instrumentation and the fact that he talks to you. We will have to compute where this thing is going to land so we can notify the estimated point to our pickup party.

One of the most serious problems is being sure you can get to the man and find him. We have to exercise this beforehand many times before we are willing to put a man in such a system.

Mr. JONAS. Do you mean the guidance system?

Dr. DRYDEN. He has only an attitude control. There is no guidance. It is a simple drag thing. The point of landing is controlled by where he is, where we fire the rockets, and what their thrust is.

Mr. BOLAND. Who fires the rockets?

Dr. DRYDEN. The doctors have not quite decided whether to give him the opportunity first and follow it up by radio command or which way to do it.

Mr. BOLAND. How long will he stay up there if he gets into orbit?

Dr. DRYDEN. An hour and a half is once around the earth. If he goes around three times, which is what we are thinking about, it is about four hours and a half.

Mr. YATES. Are we and the Russians the only ones doing this or are England, France, and others doing it?

Dr. DRYDEN. So far we are the only two nations. The British are considering whether to go into a program based on their ballistic missile development. So far as I know, no other country is able to afford it.

Mr. OSTERTAG. That was a project of IGY in which the United States and Russia were the only two countries agreeing to sponsor that?

Dr. DRYDEN. That is right. NASA was organized October 1. Immediately thereafter we formed a task group for Project MERCURY. The old NACA had been looking at this problem in its laboratories, but the real start of the project was when we formed this task group.

We mailed capsule specifications on October 23. We held a conference of bidders on November 7. We got proposals on the 11th of December. The contractor was named on January 9. He is building the capsule, spare parts, et cetera. The value of the contract is about $14 million. Development tests are specifically for this.

This chart shows you go from this to vehicles with capability of maneuver. This is the fully winged type, this is halfway between. Both of these are being studied in wind tunnels.

There is a project jointly with the Air Force and ourselves on the successor to the X–15, called the DYNASOAR, which is in general this configuration. There is some work going ahead on this. What I have not shown by charts are the tracking system development required.

SELECTION OF PILOTS

Of course, I have not gone into the matter of selections of the people who are to be involved because, just as in the X–15, you start your pilots with the beginning of the project; they work as engineers in the team; they go through training; they are involved in every step. I think most of you are familiar with the process.

We had a group of doctors from the services who wrote specifications. They required that this would be a graduate of one of the test pilot training schools, that he have experience as a jet pilot, be not over 5 feet 11 to fit into the capsule. I cannot remember all the details.

There were some 79 or a somewhat larger available number interviewed. Eighty percent of them volunteered to go ahead. Since there were sufficient people to choose from, we did not interview other graduate test pilots. There were 32, I believe, of these put through a very intensive physical and psychological examination, and from those 32, as you know, 7 were selected. They are now in the process of moving their homes to join this project with physical headquarters at the moment at Langley Field, Va.

This is the kind of subject I could talk on for a long time, but I think this is long enough. I will just repeat that it is the highest priority project—which does not mean this is the only thing that ought to be done—primarily because of its cold warfare significance, and the fact that we have some competition.

NATIONAL BOOSTER PROGRAM

Dr. GLENNAN. If we may move to the national booster program, I will ask Dr. Silverstein, Director of our space flight development activity for many years a recognized authority in the propulsion field, and previously the Associate Director of the Lewis Research Center, to proceed.

This program in 1960 is set up for about $151 million. This represents an increase of about $85 million over the program for 1959.

Mr. THOMAS. We are glad to have you, Doctor.

Dr. SILVERSTEIN. You asked the question earlier as to how NASA differed from NACA. A major point of difference is that this program for some $150 million, representing about 30 percent of our budget for 1960, is in the area of booster and engine development. These are projects that were not previously under the cognizance of NACA. We did not develop hardware of this type.

Mr. THOMAS. The wording of the act was broad enough to give you that authority if you wanted to do it.

Dr. SILVERSTEIN. We perhaps can interpret it in that fashion.

Mr. THOMAS. You have plenty of imagination. That was about the only limitation you put on the old act, was it not? I do not say that facetiously. I mean it seriously.

Dr. SILVERSTEIN. In our practice under the old act we did not.

Mr. THOMAS. In your practices you did not. You did have a good program out there in rockets, you did have one in fuels. You did a great job on it.

Dr. SILVERSTEIN. We are using this background information, of course, as the basis for the continuation of our work into this development area. The boosters of which I speak here rely in large part on the earlier research done in our laboratories and other cognizant laboratories throughout the country.

The weakest part, I think, of our whole space program, both now and in the past, has been the area of boosters. Looking back into history, I think we can see why we were not terribly space conscious in this country until the time of the sputnik, although there was the VANGUARD program which was moving along, aiming toward the flight of a VANGUARD satellite during IGY.

Mr. THOMAS. What is a booster?

Dr. SILVERSTEIN. A booster is the combination of rocket engine and tank systems that are used to provide——

Mr. THOMAS. The powerplant?

Dr. SILVERSTEIN. Yes, sir, the powerplant in simple words, made up usually of a number of stages: a first stage, which is the biggest rocket of the system; and a second stage, which is smaller, because after the bird is up to a certain velocity, you can drop off the first stage and a smaller rocket is able to accelerate the rest of the weight up to a higher speed.

Mr. THOMAS. You are going to a system of clusters; is that right.

Dr. SILVERSTEIN. Yes, sir.

Mr. OSTERTAG. But not the engine?

Dr. SILVERSTEIN. The engine is a part of the booster. The booster is made up of the engine plus the fuel system plus tankage required to supply the fuels to the engine.

We have been currently working with booster systems that were derived from the military missile program. We have been using THORS and ATLASES with upper stages that were not designed to match the missiles because we were in such a hurry to get satellites and probes aloft we did not take the time to go through the long development leadtime required to create new booster systems. One of our first acts when this organizations was formed in October was to recognize this weakness in our program. It was a grave weakness. We met together with the Defense Department, recognizing the joint need of the civilian agency and of the military to create within this country a strong capability in booster systems.

Mr. THOMAS. The military recognized that deficiency long before this Agency was created, did they not?

Dr. SILVERSTEIN. Not so much in the space area. They recognized it for missiles, and the missiles, of course, are usually one or one and one-half or possibly two-stage vehicles.

Mr. OSTERTAG. Plus guidance.

Dr. SILVERSTEIN. Plus guidance for the missions to be accomplished. However, these missions are ground-to-ground missions where you send a rocket for 1,500 or 500 miles, not missions aimed at sending bodies into space orbits or deep into space.

Mr. THOMAS. There is four or five times as much power involved?

Dr. SILVERSTEIN. There are greater powers required and better guidance.

Mr. OSTERTAG. Do you need guidance for a launching of this kind?

Dr. SILVERSTEIN. Yes, sir. The guidance has to increase its capabilities the further out you go. If we wish to go to Venus, we need guidance that is much better than if you wish to go to the moon or very much better than is needed to go from one place on the earth to another.

These are vehicles we have fired as part of our space program. The VANGUARD you are familiar with.

JUPITER C

The JUPITER-C is made up of the REDSTONE booster, the small ABMA booster, with a cluster of solid rockets on top provided by JPL.

Mr. THOMAS. Is JPL the Laboratory in California?

Dr. SILVERSTEIN. Yes, sir. This booster was the one that put the EXPLORER vehicle into orbit, our first satellite.

Mr. THOMAS. Is that a single or one and a half?

Dr. SILVERSTEIN. This is actually a four-stage booster. It has this first stage, a very large booster delivering 75,000 pounds thrust; on top are three solid stages made up of small rockets about this thick and about that big around. Eleven of these are clustered in the second stage. These fire. There are three rockets inside of this that fire subsequently and then the final single rocket that has the satellite attached to it is fired.

Mr. THOMAS. How far up is your big booster going to take you before the cluster of rockets at the top come into play?

Dr. SILVERSTEIN. About 60 miles. The second stage is fired at 200. There is a coast period after the firing completes.

JUNO

Then we go to the next booster in our program, the JUNO. It uses the JUPITER as the first stage and the same cluster of solid rockets provided by the Jet Propulsion Laboratory as the top stages. You get great capability because this rocket has a thrust of 150,000 pounds being the same rocket that is used in our intermediate range ballistic missiles.

THOR-ABLE

The THOR-ABLE is the vehicle used in the PIONEER flights, some of which were aimed toward the moon. It is made up of the THOR intermediate range ballistic missile with a VANGUARD second stage superimposed on top and a solid rocket on top of the VANGUARD, almost the same solid rocket that is used on top of the VANGUARD here.

Mr. THOMAS. You have a lot of horsepower there.

DEFICIENCIES IN PRESENTLY DEVELOPED MISSILES

Dr. SILVERSTEIN. Yes, sir. All these vehicles have grave deficiencies from the standpoint of carrying our program ahead. In the first place, their guidance is not adequate. Second, they are poorly mated. For example, these stages are far too small to match this booster stage.

What happens is we get a very low efficiency or very low return for the money invested. You might have 1 pound of payload for a thousand pounds of missile weight, whereas, with the later systems we are creating we can increase this factor by 10, getting 10 times the payload aboard for a given booster size.

We cannot use the current missiles to perform the missions that are laid out in our program by Dr. Glennan. We met together with the Defense Department and set up a national booster program to meet the needs of the civilian and military, made up of a number of different booster systems. I will go through these briefly. Dr. Glennan has mentioned some of them already.

Mr. THOMAS. Excuse me. What is going to be the main point of difference between your civilian booster and the military booster?

Dr. SILVERSTEIN. Largely in the payload it will carry.

Mr. THOMAS. More power is all, is it not?

Dr. SILVERSTEIN. Yes, we need a truck to carry the load. In the same way, the military people can use the same truck as we can to carry 5,000 pounds of load.

Mr. THOMAS. The same basic research on one will get the job done on the other, will it?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. When you get into prototype development, that is something else, but separating prototype from basic research——

Dr. SILVERSTEIN. NACA for years created the bulk of the basic research information in aeronautics and laid down the bases on which the military airplanes were developed. We will still perform this mission as a national mission and are continuing to perform it.

Dr. GLENNAN. As you go through that, you should indicate which agency has prime cognizance and responsibility for it, and it will answer the Congressman's question.

SCOUT

Dr. SILVERSTEIN. SCOUT is made up of four solid rockets, one on top of the other. We used solid propellants to get two things: one, lower cost because these rockets exist and require no major developments; there are some minor developments needed to bring them to application here, but no major developments. Secondly, with this system we can use the reliability that has been demonstrated by some of our solid rockets. The whole theory is to create a satellite system that will put 150 to 200 pounds in orbit at a cost about a fifth of that required for some of the previously described vehicles. We have found that it costs about $2½ to $3 million to fire one of these systems. We hope to do it for about a half million dollars with the SCOUT.

Dr. DRYDEN. The existing ones do not carry the weight.

Mr. RHODES. How much weight does the SCOUT carry?

Dr. SILVERSTEIN. About 150 pounds into a 300-mile orbit.

Dr. DRYDEN. Our present ones are about 80 pounds.

VEGA

Dr. SILVERSTEIN. This is a good number. The next vehicle program is the VEGA. You were asking about how much load it would carry. On this chart we show some of the load-carrying capabilities.

(Discussion off the record.)

The difference in weight between orbiting the moon and the soft landing is associated with the weight of the rocket you have to carry aloft to slow down the satellite you want to land on the moon. Otherwise it would impact the moon at a velocity of some 7,000 miles an hour and destroy itself. You have to carry a rocket powerful enough to slow it down as it approaches the surface of the moon and make what we call a soft landing.

Mr. OSTERTAG. How do you make it slow down?

Dr. SILVERSTEIN. You have to orient it so that the rocket is pointed toward the moon and by firing the rocket in this direction you slow the vehicle down the same way you would by putting the brakes on a vehicle; you get a thrust opposing the motion forward.

Mr. YATES. Do we know anything about the gravity features on the moon?

Dr. SILVERSTEIN. We want to measure it.

Mr. THOMAS. We do not know it yet?

Dr. SILVERSTEIN. We think it might be comparable to the same characteristics that bodies of that size should have, but it has not been measured. We know it grossly. It needs to be verified.

Mr. YATES. A ratio of one-sixth to ours?

Dr. DRYDEN. Yes.

Dr. SILVERSTEIN. Let me briefly discuss the VEGA. It has an ATLAS missile as the first stage. Here we utilize all the technology that has been developed on the ATLAS and all the flight experience they are accumulating now to get a capability that is fairly well proved.

Then on top of this we are having constructed a second stage using the liquid oxygen and kerosene, the same fuel as for the ATLAS. Above that we put another stage which will have a new engine of about 6,000-pounds thrust using what we call storable propellants. Here we rely on the laboratory information we have developed in the past. We know as we go out into space and have a mission that might last, for example, for 235 days to reach Mars, that during that time we have to have our fuel maintain its initial conditions without change in some part of the coast flight. If we had liquid oxygen aboard, for example, we would have to protect it during that long period of time since it evaporates at temperatures on the order of minus 270° F. This is a bad thing to try to do.

Mr. THOMAS. What is that temperature that you maintain?

Dr. SILVERSTEIN. Minus 290° F.

Mr. THOMAS. It evaporates at minus 275?

Dr. SILVERSTEIN. Approximately, yes. We are matching up the characteristics of this vehicle, the basic booster, with the upper stages. I think you will get an understanding, by comparing 6,000 pounds of load in orbit with a vehicle weighing around 300,000 pounds, that we have a ratio of about 1 in 50 between load in orbit and the weight of the vehicle. This is a much better ratio than achieved with the less advanced vehicles. We are carrying along under our cognizance the development of the VEGA vehicle.

CENTAUR

The next stage in the national program involves a new vehicle called CENTAUR, the vehicle you asked about earlier. In the second stage of the CENTAUR, we use liquid oxygen and hydrogen. The first stage is identical with the VEGA.

Mr. THOMAS. Solid fuel?

Dr. SILVERSTEIN. No. This is a high energy fuel. If you remember some of the lectures Dr. Rothrock probably gave you in recent years regarding liquid fuels, he has probably called attention to the advantages of these high energy propellants.

Mr. THOMAS. He carried us up to theory 900. Go ahead.

Dr. SILVERSTEIN. Hydrogen is a very potent fuel as compared, for example, with the kerosene that we are using in this vehicle. It has a heating value of some 2.8 times that of kerosene, or some 50,000 B.t.u. per pound as compared to 19,000 for kerosene. Because of this and because of the fact it is a very light gas coming out of the back end of the rocket nozzle, we are able to get more thrust out of the rocket per pound of fuel burned than we can with the conventional fuels. So we will have to use this fuel for our very difficult missions.

There are some problems involved. Hydrogen is not an easy fuel to deal with. Hydrogen is again a cryogenic material which evaporates at about minus 420° F., approaching much closer to the absolute zero temperature. It is a fuel that is quite light, about one-fifteenth the weight of water.

It takes bigger tanks. You will notice this second stage tank is bigger than the VEGA. However, it gives much better performance for the same weight of vehicle because the CENTAUR vehicle weighs the same as the VEGA but it has performance about twice as good for the deep space missions as has the VEGA vehicle.

This is the first step we are taking to put advanced technology into our program. We know as we move along into this program in years ahead, that if we are going to keep this country as the leader in the field, we will have to get some of our advanced technology into the art. We are using this vehicle as a means of introducing this advanced technology as early as we can because we recognize the fact that this sort of thing takes a long leadtime. If you do not start it now, we will be late and have to do a crash job on it later. This is the time to do it because we have corresponding developments in this area coming along; our change in the ATLAS is identical for the CENTAUR and the VEGA, so we can put this stage in and have a good vehicle for carrying our technology along.

Mr. THOMAS. Your justifications confuse me a little bit. In one part of it you place emphasis on your research into solid fuels. Then when you get over to this instrument where you really need the power, you go to your exotic fuels.

Can you average them out? Does each have a special purpose that the other one cannot satisfy?

Dr. SILVERSTEIN. Yes, sir. This is the point. I think the solid fuels will come into play very heavily in the space field in these areas. One was illustrated to you by Dr. Dryden. In our retrorocket system on the MERCURY we use solid rockets. These are the rockets which we will fire to slow down the capsule.

Mr. THOMAS. It is cheaper and more compact, et cetera, but for a specific purpose, for a different purpose, you will have to go to one of your exotic fuels; is that right?

Dr. SILVERSTEIN. Yes; each has its place.

Mr. THOMAS. In each instrument in your space flights you may have a cluster using solid fuel and also a cluster using exotic fuel; is that right?

Dr. SILVERSTEIN. Yes, sir. Let us go to the next type of development.

Mr. RHODES. What thrust is the CENTAUR developing?

(Discussion off the record.)

Dr. SILVERSTEIN. The CENTAUR is under the cognizance of NASA.

DELTA

Let us take the DELTA vehicle next. I should have introduced this chart earlier. This development involves the use of the THOR booster with a VANGUARD second stage and a solid upper stage. It is a multiplication of the THOR-ABLE to get higher effectiveness in orbit.

Guidance in this system is very much better than we have in the THOR-ABLE. It is usable both for satellite and deep space probe missions, and it is going to be the principal carrier for our program in the next 2 years. This vehicle does not involve any major new developments. We are contracting to purchase some of these vehicles to support our program in the several years ahead.

NOVA

The next vehicle we want to talk about is the NOVA. This is the largest vehicle we are creating within the national booster program. This 1960 request does not provide funds for development of this NOVA system. It does, however, provide funds for the development of the principal rocket in the booster. That is this rocket here, which is the million-and-a-half-pound thrust rocket. The leadtime estimated for the development of a rocket of this size is about 4 years. We have initiated a contract with Rocketdyne to develop this rocket, and its purpose is to provide the country with a booster of a size that will be required for the more difficult missions we anticipate ahead.

CORPORATIONS ENGAGED IN ROCKET DEVELOPMENT

Mr. THOMAS. Who is the head of Rocketdyne and where is it located?

Dr. SILVERSTEIN. Rocketdyne is part of the North American Aviation Corp., located in California.

Mr. THOMAS. Who is president of it?

Dr. GLENNAN. Hoffman is general manager of Rocketdyne.

Dr. SILVERSTEIN. Sam Hoffman is general manager of the Rocketdyne organization. This million-and-a-half-pound rocket development has been reviewed by all of the major technical review groups in the country, the scientific people in propulsion. It has been under review for some 2 years before this program was initiated and was accepted by all these groups as one of the most important areas of development required for advanced work in space.

At the time our organization was initiated we again reviewed this problem between the Department of Defense and NASA and decided this was an element of the program that was extremely urgent.

Mr. THOMAS. Why was it necessary to go out and create an organization and build it from the ground up in view of the fact that you had a laboratory in Cleveland? These people are not pioneers in this field.

Dr. DRYDEN. Rocketdyne built the only ballistic missile engines we had.

Mr. THOMAS. They started from scratch and you had to train everybody. Really, the only training force you had in the country was NACA Laboratory in Cleveland. Why was it necessary to put somebody else in business when you had this?

Dr. DRYDEN. They were already in business. They furnished all engines for the ballistic missile program. They have been there for years. Their factory developed and built——

Mr. THOMAS. Who bought ballistic missiles?

Dr. DRYDEN. The Air Force primarily.

Mr. THOMAS. You were the research agency for the Air Force. I repeat: Why was it necessary to go out and put this crowd in business when you had your nucleus already in existence?

Dr. DRYDEN. We have no factory at Cleveland, no production facilities, no engineering and development.

Mr. THOMAS. We are doing a research job here and you have set up in this budget $40 million for research.

Dr. SILVERSTEIN. There is continuing advanced research but this engine, in fact, is a manufacturing job with some development associated with the manufacturing. The organization that has the contract is in fact the principal manufacturer of rocket engines in the country. They are the people who are building the 150,000-pound thrust rocket engine used on our current missiles. For example, the THOR missile and ATLAS both use the 150,000-pound thrust rocket that Rocketdyne developed. This million-and-a-half-pound rocket is 10 times larger than the existing rocket. However, it will use a great deal of the technology and manufacturing know-how these people have built up, their knowledge of tooling and knowledge of the types of structure required for a rocket of this type. Of course, this was done competitively. There were others who were in a position to offer proposals before we let the contract. We accepted the proposal from Rocketdyne as being the best.

Mr. THOMAS. Who else is in the field?

Dr. SILVERSTEIN. Aerojet Corp. They are located in Azusa and Sacramento, Calif.

Mr. THOMAS. Who heads Aerojet?

Dr. SILVERSTEIN. Dan Kimball.

Dr. GLENNAN. Former Secretary of the Navy.

Mr. THOMAS. That is the first business I have heard of him missing in a long time. How did he miss this?

Dr. GLENNAN. He was president of that company before he became Secretary of the Navy.

Mr. THOMAS. Aerojet?

Dr. GLENNAN. Yes, sir; a division of General Tire & Rubber Co.

Dr. DRYDEN. This is under development, part of research and development. This is a development contract for an engine.

Mr. YATES. Are there others in the field?

Dr. GLENNAN. General Electric.

Mr. THOMAS. He started out making automobile tires and had had no experience in making tracking systems. Now he is in the business of making jets and tracking systems, too. He can do anything now.

Dr. GLENNAN. In connection with the work at Lockheed, I believe they have.

Dr. SILVERSTEIN. The engines for this will take about 4 years. Then there will be probably a 2-year development time to mesh them in with the vehicle, or probably 6 years before the complete system is ready.

SATURN

Mr. THOMAS. Do you have the SATURN?

Dr. SILVERSTEIN. SATURN is a program that involves providing a million pounds of thrust in a booster by clustering these existing 150,000-pound rockets I mentioned earlier. There will be eight of these rockets clustered together to form a total thrust of 8 times 150,000, or 1,200,000 pounds. The development program of this booster is being handled at the AOMC, which is the Army Ordnance Missile Command, under the direction of Von Braun.

Mr. THOMAS. In Huntsville, Ala.?

Dr. SILVERSTEIN. Yes, sir. This work is being sponsored by ARPA as part of our joint activity.

Mr. RHODES. That million-pound job is in process at the present time?

Dr. SILVERSTEIN. Yes, sir; it is under contract at the present time.

Mr. RHODES. How soon?

Dr. SILVERSTEIN. It will be a 4-year development.

Mr. THOMAS. Who is doing that for ARPA?

Dr. SILVERSTEIN. This is ABMA. They are using an existing engine. They are putting it together.

Mr. RHODES. Why does it take 4 years to do that using the existing engine?

Dr. SILVERSTEIN. I did not understand your question.

(Discussion off the record.)

Mr. THOMAS. Is the Army doing it on force account at the station at Huntsville or contracting it out?

Dr. DRYDEN. They are buying the eight engines.

Mr. THOMAS. Do they do their own fabricating there?

Dr. DRYDEN. That is my understanding.

BOOSTER RECOVERY

Mr. YATES. How many times can you use an engine; just once?

Dr. DRYDEN. A number of us are looking at the problem of recovering these things because of their expense.

Mr. YATES. Do they burn up with one shooting?

Dr. DRYDEN. The fuel burns up and they fall back to the ground and they break up.

Mr. THOMAS. It is a question of putting them back together?

Dr. DRYDEN. Yes; you have to put a parachute on them.

Dr. SILVERSTEIN. As part of our 1960 request, we asked for funds to study the business of recovering boosters. They are expensive objects. We would like to develop a technique for recovering them.

I think this completes my presentation on these boosters. I will be glad to answer questions.

SOLID FUELS

Mr. YATES. I have a constituent who wants to know why the military and the scientific agencies who are engaged in the use of rockets do not concentrate on solid fuels almost primarily in view of the difficulties you have with liquid fuels.

Dr. SILVERSTEIN. This is a technical question and can be answered this way. Solid fuels have certain characteristics that are very useful and certain applications for which they can be used very advantageously. However, they do not currently provide as high an energy as some of our liquid fuels and would require vehicles that would be enormously heavy in order to accomplish missions in deep space.

Mr. THOMAS. What is your home State?

Dr. SILVERSTEIN. Indiana.

Mr. THOMAS. Did that answer your question?

Mr. YATES. I do not know that my constituent will be satisfied. You do have a great many more difficulties with you liquid fuels than with your solid fuels?

Dr. DRYDEN. You get more thrust.

Dr. SILVERSTEIN. Here is a case in point——

Mr. YATES. Explain that multipurpose rocket where you use two or three different types of fuels in different clusters.

Dr. SILVERSTEIN. Here we use LOX-hydrogen because it is very efficient; you get a lot of thrust per pound of fuel. This stage takes us out on the deep space mission, providing a large percentage of velocity we need. Without this stage, our first stage would have to be very much bigger. We might have to double up the size of this engine and instead of having 1 million pounds we would need 2 million pounds. The reason we use LOX-hydrogen here is to keep down the size of this cluster here. If we used the solid here, this might have to be 5 million pounds.

Dr. DRYDEN. This might be confused with the ballistic missiles. Ballistic missiles have a tremendous premium on getting off within a few minutes. Looking at the countdown procedures we go through now, it is difficult to see that we could get a really fast response.

We mentioned ARPA has a $20 million effort on improving solid propellants because this will pay off in the payload carried in the MINUTEMAN or POLARIS missile. But the chemistry of the thing shows there is a limit, a certain ideal limit to solid propellants, and that ideal limit to solid propellants is much less than for liquid propellants.

SCIENTIFIC INVESTIGATIONS INTO SPACE

Dr. DRYDEN. The next witness is Dr. Homer Newell, Assistant Director for Space Sciences. He has previously appeared before this committee as one of the research leaders in the recent IGY program. He was previously with the Naval Research Laboratory as the head of their Atmosphere and Astrophysics Division and Science Program Coordinator for Project VANGUARD.

He will talk about the $46 million item for scientific investigations in space.

Mr. THOMAS. It is nice to see you again, Doctor. You are always a very welcome guest here.

How have you been?

Dr. NEWELL. Fine, thank you.

Mr. THOMAS. You have not been over with us recently. We had a sort of a final sweeping-up meeting, so to speak, and we were looking for you to be in attendance with all the other IGY gentlemen.

Dr. NEWELL. Yes, sir.

Mr. THOMAS. That was a couple of months ago.

Dr. NEWELL. Yes, sir; I read the proceedings.

Mr. THOMAS. It is nice to have you, and you please tell us whatever you have in mind.

Dr. NEWELL. My subject, Mr. Chairman, is the space sciences program. By space sciences, we mean scientific investigations carried out by means of sounding rockets, satellites, and space probes. This is a fundamental research area. It is the sort of research, as Dr. Glennan pointed out, that is required to lay the foundation for practical applications.

Mr. THOMAS. You have about $45 million requested for that purpose?

Dr. NEWELL. Yes, sir.

Mr. THOMAS. The request is under research and development, as well as I remember.

Dr. GLENNAN. It is at page 201 of the justifications.

Dr. NEWELL. As I go through, I will try to point out some of the practical applications that we can foresee. However, I would like to make the point that out of basic research generally the most valuable practical applications are those that you do not foresee.

We have broken down the area into a number of subareas which I think you will recognize as familiar pieces of the IGY program which include atmospheres, ionospheres, energetic particles—which covers the area of research in which Van Allen was engaged when he discovered the radiation belt—magnetic and electric fields, gravity, and astronomy.

ATMOSPHERE

The first one, atmospheres, is a complicated subject, as you are thoroughly aware. We have in the earth's high atmosphere, to which we are directing major attention in the program, weather just as complicated as the weather near the ground in the region in which we live. The weather in the upper atmosphere, however, is based on chemical changes and electrical changes, rather than on water vapor.

For example, there is a layer of ozone in the upper atmosphere and in the highest regions oxygen itself is dissociated into atomic form. So, there are just oxygen atoms up here, instead of molecules that we are able to breathe.

There are tremendous winds and the wind speeds are sometimes higher than on the earth. Winds up above this 50-mile region, in the 60- to 70-mile regions, are sometimes as fast as 200 or more miles per hour.

Mr. THOMAS. You have rockets which have measured how high? Is that only 15 miles?

Dr. NEWELL. For weather sounding the ballons go up to 100,000 feet occasionally, 80,000 feet is normal.

During IGY the research done gave us a fairly good picture of the region shown here, and some glimpse above this 50-mile altitude up to, say, 100 miles.

The picture that you see in the upper region is one of constant change and variation with geographic position and time. Our immediate program is to carry on with the momentum developed during the IGY, and to study the atmosphere at even higher altitudes.

Before proceeding to show you the program, I would like to point out that in the research to date we have had this practical application: We have developed an engineering standard atmosphere from rocket data obtained to date. This standard atmosphere is used in the design of aircraft and vehicles that would fly at these levels. It is used as a basis against which to calibrate instruments used on such space vehicles.

In the future we can hope to find out the relations between the upper atmosphere in this region and the lower atmospheric weather phenomena. This is the sort of thing that will be fundamental to a truly universal application of, say, meteorological satellites.

Mr. THOMAS. Did you mean what you said about the weather phenomenon in those two layers? Do you have any evidence that when you get up to 50 or 100 miles away it has no relationship to weather or climate?

Dr. NEWELL. We do not know at the higher altitude whether there is any relationship. This is a longer range subject to attack, but we do presently know that in this region—below 50 miles—the behavior of ozone seems to be linked with the behavior of cyclones and anticyclones in the weather region.

This gives a clue. Maybe there is some useful connection.

Mr. THOMAS. Suppose it is confined to the first 50 miles. The changes in the weather will make the meteorological problem much simpler?

Dr. NEWELL. Yes; it would, and as I will point out shortly, we have a joint program with the Weather Bureau to study this region to see what we can do about improving weather forecasting.

In the next chart is an outline of the program for the next 2 years. Actually, the chart is backward. We should read upward since we start with the first 50 miles of the atmosphere, and then go from 50 miles to 100 miles and then above 100 miles, and out to the distance of the moon and then out to planetary distances.

In each case we are interested in the pressure, density, temperature, composition——

Mr. THOMAS. Where are you going to work from principally? Are you going to work from Wallop's Island?

Dr. NEWELL. Wallop's Island, Fort Churchill, Canada, White Sands, and the Pacific installation at San Nicolas Island, Calif.

This [indicating] is the program which I mentioned the Weather Bureau has an interest in, and we are working together in the preparation of 40 sounding rockets to study the connection between the upper and lower atmosphere, and try to pin it down and find out just what it really is.

As I mentioned, in the IGY period we got a pretty good picture of the atmosphere up to 100 kilometers. We want now to pin down

the details, and to go even higher in altitude. We are in the exploration phase. We have 48 sounding rockets, 3 satellites, and 1 space probe.

Mr. THOMAS. Off the record.

(Discussion off the record.)

Dr. NEWELL. I should mention that these are experiments and not individual vehicles. Actually, one vehicle will carry a number of different experiments. This particular vehicle will carry not only the experiments indicated here, but a number of others. I will clear this up in my last chart.

IONOSPHERE

On the subject of the inosphere, the complications again are shown here. You will recall from IGY discussions that the ionosphere is the portion of the atmosphere which has charged particles, electrons, and positive and negative ions. It consists of a number of different regions, and in the daytime it shows a structure as shown here of some double layers, while at nighttime it is considerably simpler. This is due to the fact that the primary cause of the ionosphere is the sun.

Note that the scale has been changed here. This is 180 miles; whereas, on the previous chart this height was about 50 miles.

In the IGY, a pretty good picture of the ionosphere came out of the various rocket soundings and ground-based observations up to 60 miles. It gave not so complete a picture up to 180 miles, and only brief glimpses above that altitude. I might point out that the best glimpse above that altitude came from the Russian sounding rocket and Sputnik III. So, here is one area in which we have to catch up.

The complication is even greater than might otherwise be because of the presence of the earth's magnetic field, which deflects moving charged particles, and makes an understanding of the ionosphere even more difficult.

The program for the next 2 years involves seven sounding rockets to measure the electrons and ions in the ionosphere, to study very low frequency radio propagation—the frequency that the Navy, for example, uses in its worldwide communications net—to study the interactions between the ionosphere and the vehicles we send through it, what the charging effects of the ionosphere do to communications and to instruments in such vehicles. There are five satellite experiments to study the same thing, and then one space probe—which is a vehicle which goes out beyond the earth's atmosphere—to determine how far out the ionosphere actually does extend.

ENERGETIC PARTICLES

In the next area we have energetic particles, and this brings us to the Van Allen radiation belt which is one of the areas of interest in this field. This field also includes the cosmic rays which contain the most energetic particles known to man. Also included are the northern and southern lights—the aurora.

One feels, from Van Allen's experiments, that the aurora are probably caused by particles from the Van Allen belt. This is something that we want to pin down. Furthermore, we want to study in detail the structure of the belt. You brought this question up earlier this morning.

As it appears now, it seems that there is one completely isolated region, called the inner belt, and an outer belt that is more diffiused and spread out more widely. This is based upon the first observation that Van Allen has been able to make. In order to determine the complete spatial distribution we have to make more observations.

In this area the program includes one experiment to measure the cosmic ray intensity in interplanetary space. These are the highly energetic particles.

There is one satellite, plus two probe experiments to measure the cosmic ray fluctuations, and this is directed toward seeing whether or not they are related to magnetic storms and to activity on the sun. It is directed toward finding out just where they originate and how they are created. There are experiments to determine the energy and the nature of charged particles. We wish to find out just what the particles are. How many ion particles are there? How many helium, and hydrogen? There would be one deep space probe in this field plus two rockets.

To continue the study of the radiation belt, there will be two satellite experiments plus four rockets; and to study the auroras—the northern and southern lights—and to determine their connection with the radiation belt, there will be six small rockets.

MAGNETISM, ELECTRICITY, AND GRAVITY

In the next area, magnetism, electricity, and gravity, the magnetic field is of particular interest to us at the present moment because it is this field that causes the trapping of the particles in the radiation belt.

From the practical point of view we may be able to use the existence of this field to create artificial radiation belts, using them for communication purposes.

We know only about the earth's electric field between the ground and the ionosphere itself. We do not know what the field is outside of the ionosphere. The electric field must be important in connection with the charging of vehicles that go through these regions. It must also be important in connection with the auroras which in turn have an effect on communications at the surface of the earth.

Another practical reason for wanting to study the magnetic field is that when the earth's magnetic field is disturbed by incoming streams of charged particles from the sun, the field is distorted, and has a considerable effect at the surface of the earth. Sometimes the effect is strong enough to black out even telephone communication lines. It is often strong enough to black out radio communications for periods of hours.

Finally, in the case of gravity we have one of the most fundamental subjects. We do not really know what gravity is. We have been able to measure it and determine how strong it is, but we do not know what creates it. Whereas we are able to manipulate magnetic fields and electric fields in our daily use of electronics, and in sending radio messages, we are not able to do the same thing with gravity, because we do not know what gravity is. So, one of our fundamental research programs is directed toward learning what gravity is.

In the magnetic fields program we have two satellite experiments scheduled to study the electric currents in the ionosphere and in the

radiation belt that give rise to the magnetic storms on the surface of the earth that interfere with radio communications; one satellite to map out in detail the earth's field so as to enable us in future observations to pinpoint just where the disturbance sources lie that cause these magnetic storms; and one space probe to measure the magnetic fields existing between the earth and the moon and if possible to measure the moon's field.

Mr. THOMAS. Suppose you come up with some real good answers?

Off the record.

(Discussion off the record.)

Dr. NEWELL. We have 30 sounding rockets to study currents in the ionosphere and to make important tests.

I might point out that one of our policies is to test our instruments for satellites and space probes in the least expensive manner commensurate with providing a proper test, and one way is to fire things in sounding rockets before you commit them to an expensive space probe or satellite vehicle.

Finally, we have two space probe experiments to study magnetic fields out to planetary distances; for example, out to the distance of Venus. If the firing is toward Venus, it will measure magnetic fields out to those distances.

In the field of gravity, there are two experiments under preparation, one to continue the IGY satellite work on measuring the size and shape of the earth, and of refining our measurements of intercontinental distances. This, of course, has application to mapping and all the things that rely on accurate maps.

We are also preparing one satellite experiment to conduct the first controlled experiment in the field of the general theory of relativity. This area, of course, is fundamental. Out of the area of relativity came the statement of the principle that energy and mass are equivalent, and it is on this that our development and use of nuclear energies are based. The general theory of relativity, in fact, is part of the subject of gravity, and is the sort of study that will eventually help us to understand what gravity really is.

Finally, in the area of astronomy we have the opportunity with satellite stations to make observations from above the earth's atmosphere. This [indicating] is an artist's conception of such a telescopic observing station above the atmosphere. This is important, because the earth's atmosphere absorbs many of the radiations from the objects of interest, from galaxies, from the medium between the stars, and from the stars and the sun and the planets. All the radiation that lies in the far ultraviolet, the X-ray and the gamma ray wavelengths, and some of the infrared are hidden from the ground-based astronomer; and yet it is in those wavelengths that probably the most information about what is going on out in space lies.

So, in a number of astronomy experiments we hope to learn more about the fundamental workings of our universe. The astronomy program for the next 18 months includes 3 space probes to investigate the moon and planets; and 6 satellite experiments to investigate the medium of space, what is there and what is going on, including the sun, the galaxies, and the stars, and there are 35 sounding rocket systems to measure meteors in space, and to observe the stars and the radiations from our galaxy.

To tie together all these things, in the last chart is summarized the numbers of vehicles to be used. In calendar year 1959, 45 to 50 sounding rockets, using a variety of types, as you see here; 6 satellites; and 2 space probes. In calendar year 1960, on the order of 100 sounding rockets, 7 satellites, and 4 space probes.

Mr. THOMAS. What is the height of each one of those three classifications?

Dr. NEWELL. In the case of the AEROBEE something on the order of 60 to 70 miles; the AEROBEE-HI will go up to 180 miles or so with a 120-pound payload; the NIKE-ASP will go up to 150 miles; and the SPAEROBEE to over 200 miles. The other, here, is a solid-propellant vehicle developed by the NASA. The satellite vehicles have been described to you.

I might point out that these are the satellites and space probes to carry out some 37 experiments that were listed for you earlier. This indicates how one does use a vehicle for many experiments.

Mr. THOMAS. What will be the height of the satellite space probes?

Dr. NEWELL. The VANGUARD satellites range between 300 miles or so at perigee and 1,500 miles to a couple of thousand miles at apogee.

As you know, the JUNO II has a perigee on the order of 150 miles or so, and apogee less than 1,000 miles. The THOR-ABLE is able to put 200 pounds in a 300-mile orbit.

The THOR-DELTA has a similar performance capability to the THOR-ABLE, but it has better guidance, so one can call for more precision.

For space probes these vehicles can hurl on the order of 50 pounds out to the moon. The more advanced vehicles, of course, carry the bigger payloads that Dr. Silverstein showed you.

Mr. THOMAS. While we are all dealing in theory, someone suggested this morning it would save time and money and everything else if we could turn this program, or 80 percent of it, into an IGY program and get the same cooperation in this as we had in the regular IGY program. That is something to think about; is it not?

Dr. GLENNAN. Yes, sir. Not only is it something to think about, but actually we are doing some work in this area, although it will be very much more limited in scope than the IGY program, which was entirely a worldwide operation. But in our international interest here we are encouraging other nations to think with us and possibly to work cooperatively with us on some of these satellite applications. Actually, this is so much more expensive a program that the extent to which other nations other than Russia and ourselves can put the money into it is very, very questionable.

Mr. JONAS. Off the record.

(Discussion off the record.)

METEOROLOGY, COMMUNICATIONS, NAVIGATION, AND GEODETICS

Dr. GLENNAN. Mr. Chairman, we move to the application field where we hope and are quite certain that a payoff will come in the reasonably foreseeable future. I speak particularly of the fields of meteorology and communications.

Mr. THOMAS. Please tell us about it.

Dr. GLENNAN. Mr. Edgar Cortright, Chief of the Program of Advanced Technology, is going to speak to us on that. He has had a

good bit of appropriate experience in the field of propulsion research as Branch Chief at the Lewis Research Center before coming here.

Mr. THOMAS. Good.

Mr. CORTRIGHT. Mr. Chairman and members of the committee, it must be obvious by now that a strong national capability in space technology comes neither easily nor cheaply. Hence there is a very understandable desire, I think, on the part of most people to apply this ability to practical purposes as much as possible.

Mr. THOMAS. Will you please tell us about yourself before you go into that? Where are you from?

Mr. CORTRIGHT. Well, most recently from Ohio before I moved down here. I worked at the Lewis Research Center.

Mr. THOMAS. How old are you?

Mr. CORTRIGHT. 35.

Mr. THOMAS. Where did you go to school?

Mr. CORTRIGHT. Rensselaer Polytechnic Institute.

Mr. THOMAS. We are honored to have you, and more power to you.

Mr. CORTRIGHT. Thank you, sir.

Mr. THOMAS. You may proceed.

Mr. CORTRIGHT. I was about to point out, sir, that there are several problem areas which are of interest and importance to all of us which, we think, stand to benefit greatly by the use of the earth satellite. These would include meteorology, communications, navigation, and geodetics. In this talk I would like to very briefly outline the programs which we think are sensible in each of these areas.

Let us begin with meteorology.

METEOROLOGY

The reason that the earth satellite stands to benefit the science and practice of meteorology so greatly, we think, is twofold: One, for the first time it gives the meteorologist an observing platform which is equal in scope to his problem; namely, the continuous survey of all of the earth's atmosphere. Secondly, it gives him a platform which, by virtue of its unique position above the atmosphere, will make measurements that we have never had a chance to make before.

Now the first hint of what the meteorological satellite might mean to the weather people was obtained back in 1954 with a rocket fired from White Sands. This rocket went to 100 miles altitude and took a series of pictures which were pieced together into this composite photograph. Shown down here over the gulf coast of Texas is a large cyclonic disturbance exhibiting the typical spiral-shaped——

Mr. THOMAS. May I interrupt you at that point?

Did not our distinguished friend, Dr. Revelle, intimate that we are not going to get all the answers to the weather by going upstairs, and that we will have to go downstairs to get part of the answers.

Mr. CORTRIGHT. The satellite can observe, by measuring surface temperatures, tidal movements in the ocean which are intimately related with large-scale weather phenomena.

The interesting thing about this cloud pattern is that it stands out very clearly from this altitude where you get a bird's-eye view. It was missed by the ground stations of the Weather Bureau. In other words, it is very difficult to put together an observation like this from isolated observations on the ground.

Later on in the life of this high-altitude storm it caused very heavy rainfall in the Mississippi Valley and considerable damage.

We can do more with satellites, we feel, than merely observing gross cloud patterns. Some of the things that can be done are indicated in this next chart.

For example, remaining with clouds for a moment, in addition to the general coverage it should be possible to identify types and by observing individual clouds to detect wind velocities and directions. By using radar it should be possible to measure cloud heights, layers of clouds, and precipitation located underneath the clouds. By a technique known as "sterics" where one detects the static from lightning flashes it should be possible to locate thunderstorms beneath the blanket of clouds.

Now, in addition, there are a series of measurements which ought to be able to detect the distribution of water vapor, ozone, and carbon dioxide. You recall that Dr. Newell pointed out the inter-relationship of these with the weather. In addition, detectors should make possible the measurement of temperatures of the stratosphere, troposphere, cloud tops and the earth's surface.

There is also a type of experiment known as the heat balance experiment which has to do with determining the local variations in the heating of the atmosphere by the sun. It is necessary to measure the solar radiation coming in locally, and that which is reflected and reradiated from the earth. This local imbalance essentially is what tends to drive our atmosphere; the atmosphere moves around in an effort to equalize this unequal heating.

Now, a question naturally arises early in the game as to how to put together satellites into a system which makes sense and can be put to effective use by the ultimate users; namely, the people of the country through the Weather Bureau and the armed services in their operational capacity. This is a plan which is used as a guideline at the moment for our developments: It is based on the use of the following vehicles: Low-altitude satellites in polar orbits of, say, 500 to 700 miles—not a single satellite but up to six of them equally spaced. These low-altitude vehicles would make these many detailed measurements indicated in the previous chart. In addition there would be a need for a high-altitude satellite 22,300 miles above the equator. This would sit overhead of some ground positions on the equator and because it remains fixed with respect to the surface of the earth, it would be possible to direct from the ground, instruments to observe selected locations on the ground at the whim of weather observers. One could scan large areas to look for storm patterns and for local incipient storm patterns. It would be possible to observe storm growth and predict its motion.

COMMUNICATIONS PROBLEM

I might point out that one thing is not obvious from a chart like this, and that is the tremendous communications problem which is generated by the use of a system like this. Just the data from one of these satellites would saturate the current communications network across the ocean and it is necessary to have a much wider bandwidth system, probably using communications satellites, in order to get these data rapidly back from the satellite to the weather center. I need

hardly point out that weather data are extremely perishable. Two hours after a storm is over, it does not do you any good to know it was on its way. That system is a long way off, probably a decade, as an order of magnitude, and we are just at step No. 1 of getting a system like that.

This is the first meteorological satellite which was launched some time ago by the Vanguard rocket. It made use of photocells which looked out at diametrically opposite directions, 45 degrees to the spin axis. Due to the spin and the translation of the satellite across the ground, the photocells scan out a picture much like a television picture.

What the photocells saw was radioed to the ground and this picture could have been reconstructed if it had performed perfectly. This, I think, is interesting to point out as a typical heartbreak that one goes through in this type of business: The satellite was disturbed during the launching process so that instead of spinning nicely it wobbled much like an imperfect football pass. So, the succeeding scans of the ground were not regular like this [indicating], but were crisscrossed and the problem of reconstructing a picture from this type of data is almost overwhelming. We think it can be done, and work is still going on to get such a picture, but it is extremely difficult.

There will be another IGY-type experiment launched within a couple of months—a heat balance type of experiment—but the next major milestone in meteorology will occur with the launching of this satellite. This is a 270-pound satellite which spins about this vertical axis and contains television cameras, infrared detectors, magnetic tape storage equipment, transmitters, receivers, and the works. It is a fairly complicated satellite but with considerable capability. There is one scheduled for launching about the end of this year and one next spring. Beyond that, we go on to more sophisticated satellites which are controlled in altitude so they always look toward the earth.

I did give you some information on one type of communications problem, the sending of meteorological data back to this country from our readout stations overseas.

COMMUNICATIONS SATELLITES

I would like to spend some time discussing the communications satellites in general. Even the well-favored nations of the earth are in dire need of improved communications within the next 10 years. For example, across the Atlantic today we have one telephone link with approximately a 36- to 50-channel capacity and this will be saturated by 1962. It is estimated that by 1970 there will be a sevenfold increase in message units to 21 million a year. At the current rate of $12 a unit, this comes out to a potential gross income of over $200 million a year, or from a more constructive point of view, taking a look at the total invested capital required to set up a system like this, there is every hope of decreasing the rate.

What are we doing about developing the technology to support this type of improvement? Well, the NASA is interested in two types of communications satellites—the reflector type and the repeater type. First, let us consider the reflector type.

REFLECTOR-TYPE SATELLITE

This is simple in concept and it consists of putting up a reflective surface and directing a strong radio signal at it which in turn is reflected back to the ground as a weak signal covering a large area. Any suitable receiving station within that reflected wave can receive the message.

Our first experiment, which is scheduled for the end of this calendar year, will be a 100-foot-diameter sphere weighing not the 65 pounds indicated here, but closer to 175 pounds. It is made of aluminized mylar and will be placed at an altitude of 1,000 miles. There will be high-powered transmitting and receiving stations on opposite sides of the United States to perform experiments in bouncing these signals back and forth. The satellite is shown here in early development form, and this whole satellite, 100 feet in diameter, is packaged in a 30-inch diameter case. It is inflated by residual gases and water which vaporizes within the satellite.

REPEATER-TYPE SATELLITE

Now, another type of communications satellite which has great potential for the future is the repeater satellite. I might make one last point, before we leave the reflector satellite, and that is simply that they will operate eventually at relatively low altitudes—2,500 miles—and we might need as many as 25 of them to get a system that would provide uninterrupted communications. Here, in the repeater satellite, is a system that could use three more complicated satellites at 22,300 miles above the equator. A technique of using them would be to radio to the satellite, back down to the ground, out to another satellite, and back down to the ground again in order to get halfway around the earth. These are heavy satellites which contain electronic equipment. They are not quite so flexible but they are few in number.

I would like to mention that this development is being primarily pushed by the Department of Defense. We are working with them and following along and keeping up with the job. We will also develop certain types of equipment to go aboard which are more tailored to civilian-type needs.

GEODETIC AND NAVIGATION SATELLITE

Lastly, I would like to touch extremely briefly on the geodetic and navigation satellite. The continents of the earth are tied together very loosely, in geodetic terms, to about two-tenths of a mile accuracy. Within some of the more civilized continents we know transcontinental distances to 100 feet—across the United States, for example—but it is necessary from the geologist's point of view and the military point of view to tie the continents together to these same accuracies.

This, we feel, can be done with the geodetic satellites. The technique is to observe a satellite simultaneously from the different land bodies you want to tie together and to observe it visually with telescopic cameras. Another thing which can be done by observation of satellites in an extremely accurate manner is to determine more accurately the shape of the earth. Once we have determined the shape of the earth accurately, we can work backward and use that information to predict our orbits more accurately.

The type satellite being developed for this application would work something like this. It would be small and heavy so that its orbit would be stable. It would contain flashing lights, powered by solar cells and batteries, and it would have a considerable ground observing network to go with it to make these observations I am talking about within the life of the satellite.

Thank you.

Mr. THOMAS. That was a very nice presentation.

Dr. GLENNAN. Mr. Chairman, may I point out that in these application satellite programs there is a real need for integration and close coordination with the military. The communications satellite is of great importance to them. It also has great importance in commercial applications as the years go on.

The meteorology program is now managed by NASA and all of the activities have been transferred to us, but we have input from the military and actually are inviting them to have one of their men work right in our program so that there is a very close coordination.

Mr. THOMAS. Off the record.

(Discussion off the record.)

ADVANCED TECHNOLOGY

Dr. GLENNAN. If we may, we will now look at advanced technology. This will be presented by Mr. Wyatt, technical assistant to Dr. Silverstein. He came to this position from Lewis where he was associate chief responsible for research on propulsion systems in supersonic wind tunnels. He will speak of systems technology and rendezvous problems.

Mr. THOMAS. It is nice to have you with us.

Mr. WYATT. I want to talk to you very briefly about some of the advanced technology other than booster development that is necessary in advanced programing.

This chart recapitulates in one fashion the total elements of the program. We talked about the earth satellites. Dr. Newell talked about the scientific satellite experiments he would like to conduct. Then we had a discussion of certain applied satellites. I would like to touch briefly on the orbiting laboratories and some problems there. Then we have the problem of lunar exploration as the next broad phase away from the earth, probes to and near the moon, the PIONEER sort of thing, and orbiters around the moon. Finally we will want to make instrumented soft landings, referred to by Dr. Silverstein this morning. Eventually we will want to make manned landings on the moon.

Then we go rapidly beyond concrete thinking at the present time as we look ahead at the matter of planetary exploration where again we will start off with probes past the planets. Eventually we will put satellites around the planets so we can continuously observe over an extended period of time the properties we are interested in, then we will want to make soft landings, and we presume some day we will want to put men on the planets.

Also we want to probe into the sun because the sun is an interesting scientific problem since so much of our total existence depends on energy from the sun.

Mr. THOMAS. You are not going to get too close to that celestial body.

Dr. NEWELL. I would like to get within a radius of the sun, 840,000 miles from the surface.

Mr. THOMAS. It would be warm when you get there.

Dr. NEWELL. Yes; the equipment will burn up quickly, but on the way to it we can make some measurements.

Mr. WYATT. We will consider things not too far down the line, orbiting laboratories and manned landings on the moon.

SPACE LABORATORY

This chart shows the general area of activity that we call space laboratory problems. Now we view a space laboratory as an object or vehicle we put up in orbit around the earth for some extended period of time in which we can observe not the things happening outside the vehicle but what happens to things that we place in the vehicle. These can be organisms, small animals, human beings. They can be articles on which we want to build a history of reliability. That is, the problems of the sort Dr. Dryden talked about of having to make mechanisms that work, having to get bearings that do not seize in a vacuum. We would like to be able to study these over an extended period of time.

Historically there have already, of course, been studies with small animals in what we could call very elemental space laboratories using ballistic nose cones. There have been two or three of these experiments over the past year. We will extend these experiments in our Project MERCURY development, as Dr. Dryden indicated. We will be including animals in some of the early development phases of the Project MERCURY.

PROJECT MERCURY

We come to Project MERCURY itself with a potential of up to 24 hours of continuous flight with a man. We will then reach a very significant step forward as far as an orbiting laboratory is concerned. At the present time, we are able to simulate the condition of weightlessness, for example, on a man for a period of less than 1 minute by flying an airplane along a parabolic path. We can get a period of weightlessness for from 45 seconds up to a minute maximum. We will soon have the X–15 and we will have a period of weightlessness of some 4 to 5 minutes, but it will not be until we get to Project MERCURY that we will be able to really put man in a condition of weightlessness for an extended period of time, from an hour and a half on up to 24 hours maximum in that particular project.

At that time we would anticipate we will learn much, much more than we have up to that point about whether man can really tolerate weightlessness because there would be time for basic physiological processes to take place. Project MERCURY will represent a very important step in our space laboratory program.

Beyond Project MERCURY we look to two directions: one, to put more than one man up at a time and, second, to put him for a rather extended period of more than 1 day. Here we indicate we would work toward a system where for several weeks up to several months we would be able to put man or other objects into space, orbit them around, and bring them back and study the results.

ORBITING LABORATORY

From there, obviously the thing we want to go into is an orbiting laboratory that can be considered essentially permanent, not that we would sentence a man to spend the rest of his life in the laboratory, but one in which we could interchange crews, resupply, take down old instruments, put up new, and have a laboratory always in space, studying the conditions of radiation, vacuum, whatever weightlessness we want to impose upon it for as long as we want. We are looking down the road in our space laboratory programing toward eventually this sort of thing.

The next chart indicates a little more than an artist's conception. It is a sort of composite of the things we might do in a permanent space laboratory. The one we show here is one that is not outside our technological reach. If we use the very large booster vehicle, the NOVA which Dr. Silverstein spoke about, with a thrust of about 6 million pounds from the ground, it is technologically feasible, although we have not made detailed studies, to launch a vehicle of this magnitude with one shot. The VEGA will put a 150,000-pound object into a 300-mile orbit. It could be 20 to 30 feet in diameter, 80 to 100 feet long, and launched by a single vehicle.

In such a laboratory I show a composite of many uses we might put it to. We have not yet selected specifically what we will do or what we would do first, but, for example, we would have to provide living quarters for the crew, we might have biological laboratories, microbiological experiments, general physics or astronomy type experiments where we study the heavens around us. Then on this side we indicate what would be a technological laboratory section.

I do not want to dwell too much on this because it is simply an artist's conception, but it contains some of the elements that are going to be necessary to consider. For example, with men in here for an extended period of time, we do not know for sure but it is quite likely we would not want to maintain them weightless for a period of several months. We would probably want to rotate this about some center of gravity, have it rotate this way to introduce artificial gravity into the vehicle. We show this as being in two parts, separated with a connecting tube, because we spin this thing around to generate artificial gravity; we do not want to build up a condition that makes for dizziness, spinning; we would like to get the ends separated as far as possible so we can spin it as slowly as possible. We visualize this could be constructed so that these two could be together during launch for purposes of rigidity and when we begin to spin, they would extend because of centrifugal action and we would thereby get the benefit of extra length.

If you can see the small figures down at the end, over here are the crew's quarters out near the end of the vehicle in order to get a maximum G or gravity condition for general living purposes. These men in here in the crew quarters think that this is the down end of the vehicle. Over on the other side I show men in here working with the technological equipment. They think that down is at that end of the vehicle. It is because the center of apparent gravity is the center of rotation in the center.

In a technological section such as this we could conduct experiments that will be vital and necessary before we really consider going out

into an extended manned flight to, say, Venus or Mars. As Dr. Silverstein pointed out, a flight to Mars might take three-quarters of a year to get there and three-quarters of a year to return, and we might have to remain in the vicinity of Mars for over a year to find a favorable time to start back.

Any equipment launched from earth to Mars and return must be about as perfect a piece of mechanism as man has ever been able to build. We will have weight limitations. The thrust required to lift a pound of weight is so great that we are not going to be able to carry a lot of spare parts. We will carry certain necessary spares, but basically what we put into space must work.

The second point is that from the straight energy considerations involved, when you commit a vehicle on a trip to Mars, you are not going to be able to turn around 30,000 miles out and say that something has failed, let's go back to earth. Once you are committed, you will essentially have to carry out your flight path. You have to start out with a vehicle that technologically, as far as widgets and gadgets and machinery is concerned is about as perfect as you have ever built. It will be necessary to run reliability tests on the sorts of things that will make the operation critical—in a complete vacuum, with radiation, etc. It is such experiments that could be conducted here in a so-called technological section of an orbiting laboratory. We are not ready to design a laboratory of this sort yet. We do not have the booster. It could be boosted by the so-called NOVA vehicle, which will be available in some 6 or 7 years, but it is time to start studying some of the problems that are attendant with a space laboratory.

In the 1960 budget we have requested money to provide initial studies of what we have to provide and how we should construct these in order to get a space laboratory. Specifically, in the 1960 budget we are asking for some studies on much more modest laboratories than this, conversion of the Project MERCURY types capsule into a laboratory and extension to the next step beyond of providing a two-man capsule for extended periods of time.

Mr. THOMAS. Was that $3 million?

Mr. WYATT. $2 million. There is another problem that comes up when we consider the permanent laboratory, which is, it would have to be remanned, resupplied from time to time. This means we would have to bring other vehicles from the earth up and make what we will call a rendevous contact with it. In other words, we have to have a supply ship come up and we indicate up here that it would probably make contact at this end perhaps by shooting out a rope or cable with a magnet on the end, if you get the vehicles close enough, grab onto the magnet and draw it in.

Mr. THOMAS. A transfer station up there?

Mr. WYATT. We have to study it.

Mr. THOMAS. They would bring Coca-Cola along, fresh supplies and things like that?

Mr. WYATT. I know the whole discussion has that overtone, but really it is much more serious than that.

Mr. THOMAS. I cannot imagine anything more serious than having a ship meet you up there a jillion miles away.

RENDEZVOUS TECHNIQUES

Mr. WYATT. There is this serious problem: How do we locate this space laboratory relative to this vehicle moving up at thousands of miles an hour, both are moving, what are your points of reference? We need to study this problem. What kinds of guidance and communications do we need between these vehicles to assure contact? What kind of control do we need in the vehicles to make the final course alterations required to bring them in close contact? What are the best sources of power? There are many things like this we can see on the horizon as very real problems we want to study.

We are asking also in the budget for $3 million to study some of these basic problems in space rendezvous techniques and to start building some prototypes of some of the control system hardware that will be required. It is an extremely critical problem.

LUNAR EXPLORATION

Let me move from there to the areas of the problems that are raised, for example, in lunar exploration. As indicated, we look ahead to the so-called unmanned orbiter around the moon, something that would take a satellite path around the moon. The next step would probably be a hard landing, which is just that. It comes in so fast you do not expect your instrumentation to survive the impact, but you get information right to the point of impact.

Then, much more difficult because of the power requirement, is the soft landing. Then we probably go to a stage of putting a man around the moon and bringing him back but not landing him, and finally the most ambitious, this matter of taking a man to the moon, landing him, and returning him safely to the earth.

The next series of charts illustrate the magnitude of this kind of problem. We start off with a vehicle that would be almost 300 feet tall. This would generate 6 million pounds of thrust and the vehicle would weight almost 5 million pounds. The man would be housed in a tiny capsule much like the MERCURY capsule in the nose. We start off with about 6 million pounds' thrust. As we calculate now, we have not built this launching vehicle, of course—we calculate it might take four successive stages to put this on the path to the moon. The whole vehicle would be seven stages. We would fire four of them in going out to the moon. We get out to the moon. To accomplish this soft landing we have to have this thing turned around so that the rockets are pointed at the moon and slow it down as it comes in. This would be the fifth stage we would fire. We indicate here it is receiving a radio signal from a preset point on the ground.

We think before we would ever attempt to put a man on the moon we would have to demonstrate to our satisfaction that we could put objects into controlled locations. Very obviously, you would not want to land on the side of a crater, so we would put down a beacon first and we would use this beacon to guide us down to a preselected landing site. We would have fired our fifth stage by the time we got to the moon.

We take off from the moon with the sixth stage, leaving the cases of the fifth stage behind. We are leaving the moon and returning

to earth. This is by this time a very small vehicle, weightwise, and the escape velocity from the moon is very low relative to that from the earth. In a single rocket we could get the velocity which is required to return to the earth. This is the sixth stage we are firing. Then, finally, when we get back to the earth we would have to fire retrorockets, as in the case of Project MERCURY, in order to slow it down enough so it finally glided down through the atmosphere. This shows the artist's conception of the seventh stage firing.

We start off with a weight of almost 5 million pounds, which could be boosted by the NOVA rocket. We come back with a weight landed on the earth of about 2,100 pounds. This is a bare minimum of weight that would be necessary to put one man on the moon and return him. Until we have these very large rockets of the NOVA 6-million-pound class, we cannot talk about this kind of an expedition to put a man on the moon and return him.

There are problems that are connected with the NOVA booster. I believe one of you gentlemen mentioned this morning the question of recovering some of these first stage engines. This is a very critical problem, critical in the financial sense. We estimate a NOVA vehicle might cost as much as $45 million as launched. Obviously, economic sense indicates you should recover and reuse as much of that as possible.

We are very interested in getting studies started on recovery techniques for as much of such a launching vehicle as we can. We have requested in the 1960 budget the sum of $1.5 million. We have a half million dollars this year we are using to get some studies started. We have to go into some hardware and wind-tunnel testing and this sort of thing to test out ideas on how to recover elements of these very large booster systems. The money we put in will be a fraction of what we will lose with each shot if we do not have a recovery system.

STRUCTURAL PROBLEMS

The other thing about the booster vehicle of the sort required for such an expedition to the moon is it will be an enormous vehicle by comparison with any standard we have today; it might run about 300 feet high. We need to study methods of how we really want to build such a total vehicle. We are already studying how we build the big engines. We have the contracts for those engines to be developed.

However, we want to know how we build the structure to carry the very large weights in the upper stages. What about the most efficient way to carry through these loads? Should we try to carry the loads through the fuel tanks as in some current missiles or do we have separate carry-through structures? We want to know the ways to build these so they can be erected. You cannot ship a vehicle which is 300 feet long and 30 feet in diameter around the country from an assembly factory in one part of the country to a launch site at another.

Much of this will have to be erected on site. We have to build this and erect it in a suitable manner. We need to study a lot of the things associated with it in the launch site, what we need in the way of auxiliary equipment for supplying fuels, and that sort of thing.

To study these sorts of problems we have a half million dollars in our 1959 budget; we are asking for an additional $1½ million in the 1960 budget. Thank you.

Mr. THOMAS. Thank you.

Mr. OSTERTAG. In returning a satellite from the moon do you expect to actually launch the return; in other words, fire it?

Mr. WYATT. Yes, sir.

Mr. OSTERTAG. Is there atmosphere around the moon similar to that of earth that would permit that to ignite?

Mr. WYATT. No, sir. This is a problem we would have. We would have to be igniting in essentially a perfect vacuum. We have this now in some of our upper stages of the current vehicles, the requirement of lighting the engine at distances from the earth that essentially result in a perfect vacuum.

This must be solved. You must be satisfied that when you want to light that engine it will light in a perfect vacuum. We think this is not insurmountable.

Mr. YATES. You have 7 years scheduled for the NOVA rocket?

Mr. WYATT. Yes, sir.

Mr. YATES. What is the schedule for this instrument on your chart?

Mr. WYATT. We have 4 to 5 years scheduled for the engine. We think it will be about 7 years before we could have a vehicle such as this. It would be beyond that before we would attempt an expedition to the moon. We would not go to the moon the first time we had the vehicle. It might be 10 to 15 years. There is much we need to know about, through the scientific studies Dr. Newell talks about; about what are the conditions between here and the moon we must protect the man against, what are the power requirements we have to build into our vehicles in the way of auxiliary power, many things that have to be studied. These will be carried out between now and the time the vehicle is ready. We do not think we will be ready to go to the moon just as soon as we get the vehicle.

Mr. THOMAS. Thank you, Doctor.

BASIC AND APPLIED RESEARCH

Dr. GLENNAN. We have but one more presentation. Underlying all of this activity and supporting the activity in the aeronautics field we have the work at the research centers, Langley, Ames, Lewis, and Mr. Ira Abbott, who is Deputy Director of our aeronautical and space activities, and has general supervision of these laboratories. He previously appeared before your committee many times, I know, and will tell us something about the activities of these laboratories.

Mr. THOMAS. We are delighted to have you with us. You look very natural standing there.

Mr. ABBOTT. I am getting to feel very much at home in this room.

So far you have been hearing about some of the NASA programs in space technology and space sciences. I would like to change the subject at this point and talk about some of the basic and applied research which is conducted at the NASA research centers, primarily. They were the former NACA laboratories.

Mr. THOMAS. We have been waiting for you or somebody. Up until now we just about had those places junked.

Mr. ABBOTT. They are far from junked, they are very active.

Mr. THOMAS. No one had even said a kind word for them. I though maybe they transferred all personnel to some other place but you are going to tell us about it now?

Mr. YATES. It is much more prosaic subject matter, is it not?

Mr. ABBOTT. It depends on the point of view. You may have noticed in some space presentations made to you this morning, and earlier this afternoon, every once in a while somebody said the people at Langley did this, or people some place else did something else. They were mentioned several times.

As mentioned this morning, the functions and duties of the NACA were transferred to the NASA, and the most important of these functions and duties was the conduct of basic and applied research for the support of the design, development, and operation of both aeronautical and space vehicles for application to both military and civilian purposes.

At our research centers we conduct this research in such broad fields as aerodynamics, automatic guidance and control, propulsion, rockets and fuels and associated apparatus, powerplants for space vehicles, materials and structures especially for application to high temperature projects, and some associated fields.

HIGH TEMPERATURE MATERIALS RESEARCH

Mr. THOMAS. Where is that research on high temperature materials taking place?

Mr. ABBOTT. Research on high temperature materials in NASA is conducted primarily at the Lewis Research Center at Cleveland.

Mr. THOMAS. They put on one of the finest shows I ever saw at Langley 2 or 3 years ago.

Mr. ABBOTT. A growing effort in the field is taking place at Langley. The structures effort for application to high temperatures is primarily located at Langley.

This research is applicable to all types of flying vehicles, from helicopters, vertical takeoff and landing airplanes, transport airplanes, supersonic fighters, supersonic bombers, hypersonic airplanes, missiles of all types, but more especially these days such types of missiles as intercontinental ballistic missiles and antimissile missiles, satellites and spacecraft.

Mr. THOMAS. How long, in your judgment, is it going to be before the missiles will completely replace the manned airplane for delivering a warhead?

Mr. ABBOTT. I do not know the answer to that question.

Mr. THOMAS. What is your best guess, if ever?

Mr. ABBOTT. I could not guess. I think there is some reason to believe missiles may never completely replace the airplane although I think there is no doubt but what missiles——

Mr. THOMAS. That is what the military people say.

Mr. ABBOTT. I think the missile will become the primary type of vehicle in delivering warheads.

Mr. THOMAS. It is inescapable, is it not?

Mr. ABBOTT. I think it is inescapable, but at least for a long period of time, as long as the military has these airplanes and needs them, we are duty bound to do the research needed to support these projects.

You have been hearing about projects in space, and we have been supporting in our laboratories all the space programs you have been listening to this morning and we also do research that supports all space programs in the Department of Defense.

Mr. THOMAS. You had about $25 million. Interest on it now runs it up to about $25 million. You had an unexpended balance from last year of $30 million. You do not want to spend all that money on refurnishing or refurbishing this fine equipment for airplanes. We are getting out of that airplane business, are we not?

Mr. ABBOTT. I was going to mention that approximately 50 percent of all our work in our research centers is applicable to space.

Mr. THOMAS. You do not need all that money we gave you last year, then, for research on airplanes, do you?

Mr. ABBOTT. Sir, most of that money you gave us last year was not primarily for research on airplanes.

Mr. THOMAS. I thought you were going to say it was all gone. You have not spent it yet, have you?

Mr. ABBOTT. It is certainly not all spent yet, but a very large part of it is obligated and structures are going up at a rapid rate.

I would like to talk first about some of the work we do on missiles and come back to these other things because the airplane applications do remain very important although they no longer are the predominant part of the work that they were a few years ago.

These missiles have all types of problems and I and others have been telling you about some of these problems, and the work we have been doing on them, for many years, so I will not attempt at this time to go through all that again.

There are problems on engine performance, the rockets on which we are doing research both with regard to the rocket engines, combustion, fuels, assorted apparatus such as pumps et cetera.

Control and guidance is fairly obvious. Structural efficiency and integrity has to be considered. Structural work is going on especially for higher temperature application.

Aerodynamic heating, which we think of primarily in connection with the reentry problem. I have told you in previous years about some of our work on that. Then there is the work on high temperature materials.

Consequently, this year I will do no more than remind you we do work on all these problems and I will turn to some of the more prosaic problems to illustrate the nature of our work.

Before doing that, I have listed on this chart the names of missiles to which we have contributed substantially in the recent past.

Mr. THOMAS. You are overlooking your materials down there. What are you doing in materials out at Cleveland, heat resistant materials? What have you come up with? What was that heavy black material you had last year that would take a temperature of way up to 2,000 degrees?

Dr. SILVERSTEIN. We worked with molybdenum.

Mr. THOMAS. What does it look like now?

Dr. SILVERSTEIN. The problem has been in protecting molybdenum from oxidation.

Mr. THOMAS. Is it your best bet now?

Dr. SILVERSTEIN. It is a good bet.

Mr. THOMAS. What about your source of supply?

Dr. SILVERSTEIN. Molybdenum is not a problem of supply. It is a problem of working with the material. It is brittle and difficult to work and, of course, it has the problem of oxidation which is very serious. You have to protect it from the atmosphere at high temperatures.

Mr. THOMAS. It is a heavy material, is it not?

Dr. SILVERSTEIN. Yes.

Mr. ABBOTT. Here is a sample of a molybdenum sandwich material which shows how such material can be fabricated into a light structure, which has been one of the real problems with it.

We also are doing work on such things as tungsten, with very much higher temperature capabilities, and work is still going on in connection with ceramics, which are capable of withstanding very high temperatures but have a great many problems, especially in connection with the fact that they are brittle.

I think it was last year, Mr. Rhode, I believe it was, talked about some of the work on ceramics in which we have been able to grow crystals of ceramics which were not brittle, but I am afraid it has not progressed very far beyond this ability to grow individual crystals yet. We still have hopes for such things.

I had merely listed all these missiles here, all of which I think you will recognize, to show we are working on the problems of a great variety of missiles of all types. We have been able to make substantial contributions to all these missiles.

BASE FLOW PROBLEM

I have here just one illustration of a problem in which we have been able to make some substantial contribution. This has to do with the base flow problem of missiles. You see a typical missile base with these rocket nozzles which are swiveled in order to guide the missile. The problem with missiles like this was that some of that fuel-rich exhaust from these rockets was carried back up into this base cavity where because of high temperatures it caught fire and burned.

We worked on this problem and this chart shows one type of solution to it which we have developed and which is now being applied to several missiles.

Tests like this were possible only because we had large transsonic and supersonic wind tunnels which are needed for the work and in which small-scale rockets could be run to make these tests.

Incidentally, configurations such as this also improved the hinge moments on these nozzles—provided more regular hinge moments on the nozzle—and hence imposed fewer problems on the control gear in the missile.

Similar solutions are now being applied to substantially all our missiles. I give this merely as one illustration.

I will turn now to the bomber problem. Off the record.

(Discussion off the record.)

X–15 AIRPLANE

Mr. ABBOTT. In 1952 NACA initiated a program to study the possibilities of very high speed flight both inside and outside the atmos-

phere. This was our first attempt to study the possibilities of space flight.

By 1954 these studies had progressed to a point where a research airplane to explore the first problems of such flight appeared to be feasible and desirable. At this point, 1954, we made a presentation to the Air Force and Navy which resulted in the X–15 research airplane program, which is a cooperative venture between the Air Force, Navy, and NASA.

I have a model of the X–15, which I am sure you have seen before. It is deceptively conventional looking. It is built externally of inconel, a high temperature nickel alloy, and internally has a great deal of titanium. The fuselage is very much like a ballistic missile with rocket engine in the rear and most of the fuselage contains tankage for fuel and oxygen.

This airplane has now reached the stage where two airplanes have been delivered to the Edwards Air Force Base where they are now in the stage of getting ready to conduct the manufacturer's flight test program before they will be turned over to us for the flight test program.

A typical flight on an airplane like this is shown in this chart. It will be carried aloft at Edwards by a B–52 airplane to approximately Wendover, Utah, where it will be dropped from the wing of the airplane.

Mr. THOMAS. From what altitude?

Mr. ABBOTT. At the point where it is dropped from the B–52 it will be roughly 40,000 feet. At this point the rocket engines will be fired, the airplane will climb at a steep angle. The point where the rocket fuel burns out depends on the programing of the flight. The airplane will then coast up to the peak altitude shown.

During that coasting flight up, over the peak, and back the pilot will be in essentially a weightless condition because this is a ballistic flight. This weightless condition will last approximately 5 minutes in this airplane. The airplane then reenters the atmosphere and pulls out, at which time it undergoes a great deal of heating. The temperatures on many parts of the airplane will get up to 1,200 degrees Fahrenheit. This range from Wendover to Edwards is instrumented.

Mr. THOMAS. At what speed will it enter the air?

(Discussion off the record.)

Mr. ABBOTT. During this weightless period, it jumps out of the atmosphere much as a fish jumps out of water. When it is out of the atmosphere it has no air to provide aerodynamic control, so it has to be controlled as to attitude by small rockets located on the wing tips and on the fuselage. The pilot uses these rockets to control the attitude so he will reenter the atmosphere at a safe angle of attack.

Mr. THOMAS. What kind of a cabin will the pilot be in? Is it pressurized? Is he just supplied with oxygen? What is it?

Mr. ABBOTT. As in the case of the MERCURY capsule, every attempt is made to provide for safety. He is in a pressurized cabin and is in a pressurized suit inside this pressurized cabin.

An airplane like this is an important step in learning about the problems of very high speed flight in the upper reaches of the atmosphere, and also in providing some early information about some of the problems of space flight. He would be weightless, as I said, for

approximately 5 minutes so we can study the pilot and his reaction to this condition. We can also study these reaction controls outside of the atmosphere. We have been conducting programs at very high altitudes on reaction controls using an X–104 airplane equipped with them. Many of these problems, as you know, are somewhat similar, although different in detail, to those that will be encountered in the MERCURY program.

In order to show what the overall problems are, I would like to go to this next chart. I have plotted here altitude in miles against speed in miles per hour, and this multicolored band shows the corridor for continuous flight in the earth's atmosphere. It starts at lower altitudes and lower speeds and goes up to satellite speeds and altitudes. To orient you on the chart, I have put the level flight performance of the B–70 here and that of the X–15 here in red. The X–15, as shown on the previous chart, can jump out of this corridor up to very high altitudes and back down again, but while it is doing so it is essentially in ballistic flight because it cannot fly continuously and level up there.

The reason for this is, of course, that there just is not enough air up there to support an airplane or missile in level flight. Down below this corridor the air is too dense, so that below this corridor the pressures on the aircraft or missile would be too great, and the temperatures too hot, to withstand continuously.

In 1956 when we were working very hard with the Air Force, the Navy, and North American Aviation on the problems of the X–15, the X–2 airplane on separate flights reached an altitude of about 25 miles and a speed of about 2,150 miles an hour. This is the highest and fastest that man has flown to date.

It was obviously time for us to take stock of where we were and where we wanted to go. We did that and decided the region we really needed to explore was this yellow region in the flight corridor up through here following the X–15. This is particularly true because the worst heating problem and consequently the most difficult structural and material problems encountered on any vehicle of this type occurs at about 12,000 to 14,000 miles an hour in this corridor.

I might add that ballistic missiles dive in on paths such as this. Future ones will be on even lower paths, so they suffer very high temperatures for short periods of time, but the thing that saves them and makes them possible is that these temperatures only exist for short periods. A capsule like the MERCURY capsule you heard about this morning comes down essentially along the lower edge of this corridor.

Essentially, the most difficult materials and structures problem occurs in this corridor at a speed of 12,000 to 14,000 miles an hour and we decided this was our next goal. If we get through this, we can fly anywhere in the atmosphere up to, and out into, space. We decided to tackle the hardest problem next and all the others would then fall into place.

We had been studying this problem in our laboratories, and other people, particularly the Air Force, were also doing some thinking about this type of problem. In 1957 the Air Force and NACA agreed on the DYNA SOAR I program as a cooperative research program between the Air Force and the NACA at that time; NASA at the present time.

This is a winged vehicle such as Dr. Dryden showed on the last chart of his MERCURY presentation, which has the objective of being able to explore this complete corridor all the way from the speeds and altitudes of the X–15 up to and including satellite speeds. A typical flight is shown on this chart. It is launched from the ground with a larger booster, like a missile booster, the configuration and size of the booster depending upon the speed and altitude to which we wish to propel this vehicle.

A vehicle of this sort would be able to land at any large airplane runway. Of course, with larger missile boosters, a vehicle like this would be able to go farther. For instance, it could completely circumnavigate the earth at the outer fringes of the atmosphere and, in time, with sufficient boost, it could become a winged satellite such as Dr. Dryden mentioned this morning.

This program is going along, competition has been underway for some time now between two contractors, and at the moment it is being evaluated. This completes my presentation.

Mr. RHODES. This has no independent powerplant?

Mr. ABBOTT. It has no independent powerplant for the major part of the flight. It looks at the moment as though we might put in this machine a small jet engine that would give it capability of doing a little circling before it landed.

RESEARCH CENTER EMPLOYEES

Mr. THOMAS. We have quite a few people at your various laboratories under NACA, some 8,500 or 8,700 if I remember correctly. How are you going to send which of those people into your new program? Are you going to have any difficulty in doing that?

Mr. ABBOTT. Perhaps I should let Dr. Glennan speak to that but, from my point of view, I think we have no difficulty.

These people at our research centers were actively engaged in research, both basic and applied, on all types of vehicles before there was an NASA. They were making a very rapid shift in emphasis, before the NASA was formed, to the problems of space vehicles and high performance missiles.

This activity at the research centers is being continued. This shift of emphasis is continuing, but, I would like to emphasize, without our neglecting the proper amount of work that should be continued to be done in the aeronautical field.

In addition to that, a considerable number of these people have transferred over to other duties in the NASA and are playing a very important role in the space programs you heard about previously. I think the transfer, from my point of view, has been very pleasant and very effective.

Dr. GLENNAN. I think what we have here is an almost continuous spectrum of interest in our plans, in high temperature materials and speeds of flight and altitudes, to which we can reach, and that the techniques that were basic to atmospheric flight some years ago continue to be applied. As new knowledge is developed, we are able to go higher and faster.

The people who have worked in one area do not find it difficult to translate their capabilities into another area. I think what we would be most concerned about here is that we lose entirely an interest in

the aircraft business. This is going to be with us a long time, problems of safety, stability, all of the problems that have bothered us for years are going to be with us. We are making certain that a sufficient amount of our effort continues to be expended in this general field of atmospheric problems.

Mr. THOMAS. At least the military agrees with you.

Dr. GLENNAN. There are about 8,000 people in these research centers.

Mr. THOMAS. You go ahead with your program now.

Dr. GLENNAN. We have completed our discussion for you and are willing to answer questions.

SUMMARY OF APPROPRIATIONS

Mr. THOMAS. I think that was very helpful and time well spent. We will put page 2 in the record at this point.

(Page 2 follows:)

Appropriation summary—Fiscal years 1959 and 1960

	Fiscal year 1959				Fiscal year 1960 regular estimates
	Appropriated			Supplemental estimates	
	NACA	NASA	Total		
Salaries and expenses	$78,100,000	$5,000,000	$83,100,000	$3,354,000	$94,430,000
Research and development		50,000,000	50,000,000	20,750,000	333,070,000
Construction and equipment	23,000,000	25,000,000	48,000,000	24,250,000	57,800,000
Total appropriations	101,100,000	80,000,000	181,100,000	48,354,000	485,300,000
Transfers from Department of Defense			154,619,532		
Air Force	$57,800,000				
ARPA	67,200,000				
Navy (VANGUARD)	25,541,282				
Army (JPL)	4,078,250				
Total obligational authority			335,719,532	48,354,000	485,300,000

Mr. THOMAS. I notice you have here a very good table. You show for "Salaries and expenses," a 1959 supplemental estimate of $3,354,000. That is for your Pay Act costs?

Dr. GLENNAN. Yes.

Mr. THOMAS. You did not absorb any of your Pay Act costs?

Dr. GLENNAN. No.

Mr. ULMER. That is the full cost.

Mr. THOMAS. For "Research and development," a supplemental of $20,750,000. That is in the budget before us now.

Dr. GLENNAN. That is correct.

Mr. THOMAS. "Construction and equipment," a supplemental of $24,250,000, which is in the budget now. That gives a total supplemental of $48,354,000.

Your regular 1960 budget, "Salaries and expenses," $94,430,000. In that you have a base of $3,354,000 for your Pay Act increase, which will give you about what, $7 million increase in personnel over last year?

Mr. ULMER. The $94 million includes all personnel at the new salary rates.

Mr. THOMAS. How much increase is that over last year?

Mr. ULMER. For personal services it is an increase of about $11 million.

Mr. THOMAS. $11 million rather than $7 million?

Mr. ULMER. That is right.

Mr. THOMAS. Your "Research and development" for the regular 1960 bill is $333,070,000; "Construction and equipment," $57,800,000; which gives a budget for 1960 of $485,300,000; is that correct?

Dr. GLENNAN. That is right, sir.

FUTURE INCREASES FOR PROGRAM

Mr. THOMAS. How long do you think this program will go on? Will it go at an accelerated pace in terms of expenditures or will it decrease or will it stay at this present level?

Dr. GLENNAN. Mr. Chairman, I think this program for the next several years is going to have some increase each year. I have testified before other committees of the Congress that it would be my guess that within 2 or 3 years we might be for a year or two at a rate of a billion dollars a year.

Mr. THOMAS. What committees were you testifying before?

Dr. GLENNAN. The House and Senate Space Committees.

Mr. THOMAS. Legislative committees?

Dr. GLENNAN. That is right, sir.

Mr. THOMAS. A billion dollars. For personnel, salaries and expenses, research, or construction?

Dr. GLENNAN. Largely in the research and development area. Some portion of it for construction, but the major increases would be in the research and development programs. As these booster programs progress, these are tantamount to missile programs in many ways. They parallel that type of development. You will recall, I am sure, that the missile programs are not cheap.

Mr. THOMAS. Your expense will grow in proportion to the success of your booster program because your booster program will furnish you the starting point for your future investigations; in other words, for your future research?

Dr. GLENNAN. That is right, sir. That is why you see a very substantial proportion of this budget devoted to vehicular developments. The sooner we get on with getting reasonable payload capabilities, the cheaper the long-range cost of the scientific explorations we want to undertake.

Mr. THOMAS. That is understandable.

Mr. RHODES. Are we considering the supplemental request for the rest of fiscal 1959 or the 1960 budget?

Mr. THOMAS. We are going into broad general figures. We will discuss them both simultaneously. We will have to keep them separate, the regular from the supplemental, but it will be easy to do.

COMPARISON OF ESTIMATES FOR RESEARCH AND DEVELOPMENT, 1959 AND 1960

Dr. GLENNAN. May I point out that in your remarks just now you compared an R. & D. figure of $50 million for fiscal 1959 with $333 million for fiscal 1960. I think one has to take into account the 1959 transfers from the Department of Defense.

Mr. THOMAS. I overlooked that. You have roughly $155 million in transferred funds.

Dr. GLENNAN. That is right, sir.

Mr. THOMAS. In all, you have about $205 million for 1959 against $333 million for 1960, which is about a 60 percent or 65 percent increase.

Dr. GLENNAN. Fifty percent, if you consider the 1959 supplemental.

Mr. THOMAS. Yes, you have a supplemental R. & D. request of $20,750,000.

Dr. GLENNAN. About $225 million in 1959 against $333 million in 1960.

FUNCTIONS OF THE SPACE COUNCIL

Mr. THOMAS. The act sets up a Space Council. The act says:

SEC. 201. (a) There is hereby established the National Aeronautics and Space Council (hereinafter called the "Council") which shall be composed of—

(1) the President (who shall preside over meetings of the Council);

(2) the Secretary of State;

(3) the Secretary of Defense;

(4) the Administrator of the National Aeronautics and Space Administration;

(5) the Chairman of the Atomic Energy Commission;

(6) not more than one additional member appointed by the President from the departments and agencies of the Federal Government; and

(7) not more than three other members appointed by the President, solely on the basis of established records of distinguished achievement, from among individuals in private life who are eminent in science, engineering, technology, education, administration, or public affairs.

How many jobs does the act set up for the Council? Has the Council been completely staffed?

Dr. GLENNAN. Not fully, sir. The President can appoint an executive secretary at a salary rate of $20,000 per year.

Mr. THOMAS. These Council members are not salaried people as far as you are concerned?

Dr. GLENNAN. That is right.

Mr. THOMAS. You are concerned with section (f), which says:

The Council may employ a staff to be headed by a civilian executive secretary who shall be appointed by the President by and with the advice and consent of the Senate and shall receive compensation at the rate of $20,000 a year. The executive secretary, subject to the direction of the Council, is authorized to appoint and fix the compensation of such personnel, including not more than three persons who may be appointed without regard to the civil service laws or the Classification Act of 1949 and compensated at the rate of not more than $19,000 a year, as may be necessary to perform such duties as may be prescribed by the Council in connection with the performance of its functions. Each appointment under this subsection shall be subject to the same security requirements as those established for personnel of the National Aeronautics and Space Administration appointed under section 203(b)(2) of this Act.

There are only four people on the staff of the Council?

Dr. GLENNAN. Actually, as of the present time there are only two people who are fully in the employ of the Council.

Mr. THOMAS. What is the limitation of the number you can appoint on the Council?

Dr. GLENNAN. This would be whatever the President might wish to authorize, I believe.

Mr. THOMAS. It is not the President. It is the secretary.

Dr. GLENNAN. The secretary in this instance works for the President, as I see it. The Council is the adviser to the President.

Mr. THOMAS. That is right but I think, according to a strict interpretation of the act, the secretary can appoint as many people as he wants to.

Dr. GLENNAN. As of now, Mr. Chairman, the President has thought best, I believe—I can only speak for him in the sense that I know what has happened—to work with this Council for a time until he determines the extent to which he needs to staff it. Thus far, there are two people, Mr. Franklyn W. Phillips and his secretary, who are direct employees of the Council. We have in my office a man who spends part time in support of this activity, and in the Defense Department is a man who spends part time in support of the activity.

Mr. THOMAS. What are the duties and functions of the Space Council?

Dr. GLENNAN. The Council advises the President with respect to the duties which he carries out under subsection (e) of section 201. This is to survey all significant aeronautical and space activities, to develop a comprehensive program, et cetera. If there is difficulty in determining whether the military or the civilian agency should undertake a particular problem, the Council advises the President with respect to that.

Mr. THOMAS. Where is that set out in the act?

Dr. GLENNAN. It is set out in section 201(e), subsections 1, 2, 3, 4, and 5.

Mr. THOMAS. It says: "It shall be the duty of the President," and of course this Council is going to do this work for him?

Dr. GLENNAN. They advise him.

Mr. THOMAS. The act says as follows:

(1) Survey all significant aeronautical and space activities, including the policies, plans, programs, and accomplishments of all agencies of the United States engaged in such activities.

Of course, the Council will do this for the President; is that it?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. It further says:

(2) Develop a comprehensive program of aeronautical and space activities to be conducted by agencies of the United States.

Dr. Glennan, take a look at section (d).

It reads as follows:

It shall be the function of the Council to advise the President with respect to the performance of the duties prescribed in subsection (e) of this section.

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. Well, of course, the President's function is set out. So that means that is the function of the Council. Who it going to run the show? The Administrator or the Council?

Dr. GLENNAN. I think there is no question in this instance of who has responsibility for managing the civilian element of the space activity of the Nation, and that is the Administrator of NASA. On the military side, Mr. Chairman, the responsibility for management——

Mr. THOMAS. Can you pinpoint that in the act?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. You have the President over here in one section almost in command, and you have a Council appointed by the President, and the President has certain duties. The President's duties are (1)—

survey all significant aeronautical and space activities, including the policies, plans, programs, and accomplishments of all agencies of the United States engaged in such activities.

I do not know what that word "survey" means.

The act further says in subsection (2)—

Develop a comprehensive program of aeronautical and space activities to be conducted by agencies of the United States.

This is going to be done through his Council?

Dr. GLENNAN. May I point out——

Mr. THOMAS. And, then, read the duties of the Administrator:

SEC. 202. (a) There is hereby established the National Aeronautical and Space Administration (hereinafter called the "Administration"). The Administration shall be headed by an Administrator, who shall be appointed from civilian life by the President by and with the advice and consent of the Senate * * *. Under the supervision and direction of the President * * *.

Mr. YATES. Who is the boss?

Dr. GLENNAN. The President.

Mr. THOMAS. It further says as follows:

The Administrator shall be responsible for the exercise of all powers and the discharge of all duties of the Administration.

Mr. YATES. You are an independent agency?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. Further quoting from the act:

Under the supervision and direction of the President, the Administrator shall be responsible for the exercise of all powers and the discharge of all duties of the Administration, and shall have authority and control over all personnel and activities thereof.

Well, it looks like a situation which sets you up as a boss in one paragraph and the paragraph right beneath it sets up the Council as the boss.

Who is the boss?

Dr. GLENNAN. May I point out, Mr. Chairman, that this was not a law that the President wrote. This was written by the Congress, and from my standpoint the function of the Administrator as written on page 4 of the act, section 203, says:

SEC. 203. (a) The Administration, in order to carry out the purpose of this Act, shall—

(1) plan, direct and conduct aeronautical and space activities;

(2) arrange for participation by the scientific community in planning scientific measurements and observations to be made through use of aeronautical and space vehicles, and conduct or arrange for the conduct of such measurements and observations;.

It is, I think, only reasonable that an agency such as this in the executive branch finally reports to someone, and that someone is the President of the United States, and I report to him in that sense.

Mr. THOMAS. What is the Council going to be doing?

Dr. GLENNAN. It advises him on the questions which he may ask of the Council.

Mr. THOMAS. Why should he not advise with you if you are going to report to him?

Dr. GLENNAN. He does advise with me.

Dr. DRYDEN. It is comparable to the Security Council.

Mr. THOMAS. I cannot see the function of the Council here. What was the intention of the Congress in setting it up?

Dr. GLENNAN. I believe the dual responsibilities of the military agencies and the civilian agency in the space field gave them concern. In order to avoid duplication as much as possible they set up a mechanism which would advise the President on matters where there might be conflict.

Mr. YATES. Is this comparable to a board of directors and officers of a corporation?

Dr. GLENNAN. It has some similarity, but a board of directors has real power in a corporation, and the Council here is advisory.

I would point out, Mr. Chairman, that there has been no difficulty whatsoever in this matter.

Mr. THOMAS. I hope there will not be any.

Dr. GLENNAN. I hope it continues that way.

Mr. THOMAS. And as long as we have good administrators like you and Dr. Dryden I know you are not going to let any difficulties come up.

Gentlemen, we shall recess at this time, and resume at 10 o'clock in the morning.

THURSDAY, APRIL 30, 1959.

SALARIES AND EXPENSES

Mr. THOMAS. The committee will please come to order. When we adjourned yesterday we were taking a look at the overall personnel setup. As well as I recall, there is appropriated for 1959 in round figures, 8,961 positions. For 1960 there is an increase of 1,027, making 9,988.

We will insert pages 5 and 6 in the record at this point.

(The pages referred to follow:)

Salaries and expenses, fiscal years 1959 and 1960

Page No.	Establishment	Number of employees			1959 allotments	1960 estimates
		1959	1960	Change		
8	NASA Headquarters	336	486	+150	$4,864,850	$6,409,000
9	Langley Research Center	3,333	3,333		30,683,000	32,724,000
10	Ames Research Center	1,509	1,509		16,487,150	18,352,000
11	Lewis Research Center	2,828	2,828		27,606,000	31,733,000
12	High-Speed Flight Station	322	322		2,833,100	3,354,000
13	Space Projects Center	527	1,247	+720	2,639,600	14,744,750
14	Pilotless Aircraft Station	97	250	+153	1,241,920	3,626,000
15	Patrick Office	3	3		27,400	55,250
16	Western Coordination Office	4	8	+4	49,605	80,000
17	Wright-Patterson Liaison Office	2	2		21,375	22,000
7	Total	8,961	9,988	+1,027	86,454,000	111,100,000
	Funded under "Research and development"					−16,670,000
	Total appropriation				[1] 86,454,000	94,430,000

[1] Includes anticipated supplemental (Classified Pay Act increase) in the amount of $3,354,000.

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National Aeronautics and Space Administration, Fiscal Year 1960 Estimates

Summary analysis of personal services

	NASA Headquarters	Langley Center	Ames Center	Lewis Center	High-Speed Station	Space Center	Wallops Station	Patrick Office	Western Office	Wright Office	Total
1958											
Authorized end of year employment:											
Number	(174)	(3,216)	(1,455)	(2,697)	(300)	.....	(83)	.....	(4)	(2)	(7,931)
Cost	$1,386,209	$21,603,765	$9,922,250	$18,894,170	$1,977,221	.....	$466,889	.....	$39,060	$18,610	$54,308,174
Actual end of year employment:											
Number	(170)	(3,213)	(1,445)	(2,678)	(297)	.....	(83)	.....	(4)	(2)	(7,892)
Cost	$1,358,760	$21,593,344	$9,849,321	$18,863,868	$1,976,062	.....	$466,436	.....	$39,060	$18,610	$54,165,461
1959											
Estimated end of year employment:											
Number	(336)	(3,333)	(1,509)	(2,828)	(322)	(527)	(97)	(3)	(4)	(2)	(8,961)
Cost	$2,678,304	$22,834,525	$10,553,600	$20,038,435	$2,180,418	$4,230,869	$566,470	$37,950	$39,210	$18,760	$63,178,541
Net cost of positions	$2,125,500	$22,079,350	$10,159,075	$19,291,399	$2,089,579	$1,948,050	$530,740	$19,850	$39,190	$18,762	$58,301,495
All other personal services	$45,500	$189,750	$140,325	$194,802	$36,775	$50,750	$17,130	$150	$151	$72	$675,405
Total personal services	$2,171,000	$22,269,100	$10,299,400	$19,486,201	$2,126,354	$1,998,800	$547,870	$20,000	$39,341	$18,834	$58,976,900
1960											
Within-grade salary advancements	$20,000	$57,585	$52,500	$51,500	$11,400	$14,850	$3,000	$150	$300	$150	$211,435
New positions:											
Number	(150)	.....	.....	.....	.....	(720)	(153)	.....	(4)	.....	(1,027)
Cost	$1,200,000	.....	.....	.....	.....	$5,760,000	$1,224,000	.....	$26,015	.....	$8,210,015
Estimated end of year employment:											
Number	(486)	(3,333)	(1,509)	(2,828)	(322)	(1,247)	(250)	(3)	(8)	(2)	(9,988)
Cost	$3,896,304	$22,891,525	$10,606,100	$20,089,935	$2,191,818	$10,005,719	$1,793,470	$38,100	$65,525	$18,910	$71,599,991

Estimated end of year employment:											
Number	(486)	(3, 333)	(1, 509)	(2, 828)	(322)	(1, 247)	(250)	(3)	(8)	(2)	(9, 988)
Cost	$3, 898, 304	$22, 892, 110	$10, 606, 100	$20, 089, 935	$2, 191, 818	$10, 005, 719	$1,793,470	$38, 100	$65, 525	$18, 910	$71, 599, 991
Deduct regular lapses	$26, 704	$229, 725	$104, 900	$200, 535	$22, 018	$42, 289	$5, 570	$250	$325	$105	$632, 421
Deduct new position lapses	300, 000					1, 440, 500	306, 000		6, 500		2, 053, 000
Deduct within-grade lapses	20, 000	57, 585	52, 500	51, 500	11, 400	14, 850	3, 000	150	300	150	211, 435
Add terminal leave	8, 000	38, 000	30, 000	56, 000	4, 500	10, 000	500				147, 000
Net lapse deduction	338, 704	249, 310	127, 400	196, 035	28, 918	1, 487, 639	314, 070	400	7, 125	255	2, 749, 856
Net cost of positions	3, 559, 600	22, 642, 800	10, 478, 700	19, 893, 900	2, 162, 900	8, 518, 080	1, 479, 400	37, 700	58, 400	18, 655	68, 850, 135
Intermittent employment	15, 000					90, 000					105, 000
Regular pay for excess days	30, 100	176, 000	81, 500	154, 500	16, 900	76, 970	13, 800	300	500	145	550, 715
Overtime and holiday pay	11, 700	43, 000	35, 000	50, 000	30, 000	65, 000	25, 000				259, 700
Nightwork differential		38, 000	63, 000	63, 000	100	15, 000	2, 000	250			181, 350
Uniform allowances	100	1, 100	1, 000	5, 500	100	1, 000	1, 800				10, 600
Reimbursable details	18, 500										18, 500
All other personal services	75, 400	258, 100	180, 500	273, 000	47, 100	247, 970	42, 600	550	500	145	1, 125, 865
Total personal services	3, 635, 000	22, 900, 900	10, 659, 200	20, 166, 900	2, 210, 000	8, 766, 050	1, 522, 000	38, 250	58, 900	18, 800	69, 976, 000

NOTE: Figures in parentheses indicate nondollar amounts which are not included in totals.

NASA HEADQUARTERS

You have your personnel scattered around in four or five places in the District of Columbia. This table shows how many personnel are in the headquarters.

There are 336 for 1959 against 486 for 1960, an increase of 150.

RESEARCH CENTERS AND HIGH-SPEED FLIGHT STATION

For the Langley Research Laboratory you show 3,333 for each year. The Research Center at Ames, 1,509 for each year. No increase. Lewis Research Cetner in Cleveland, 2,828. No increase. High Speed Flight Station at Edwards, Calif., 322. No increase. That is an Air Force installation. Have you folks taken it over?

Dr. DRYDEN. We have some land and one building there, a combined hangar-office-shop building.

Mr. THOMAS. It is the newest one out there.

Dr. DRYDEN. It has been there about 6 years.

Mr. THOMAS. You mean that was built with your money?

Dr. DRYDEN. Yes.

Mr. THOMAS. What did that building cost?

Mr. ULMER. About $4 million.

SPACE PROJECTS CENTER

Mr. THOMAS. It is the only nice building there.

You have a Space Projects Center, 527 in 1959, and you jump that up to 1,247, an increase of 720.

What are you doing with 527 people there against a headquarters figure of 336? You have not been there long enough to get ground broken.

Dr. GLENNAN. These Space Projects Center people are presently located in several buildings in the Washington area; another group is at Langley; a smaller group is at Cleveland. The Project MERCURY people at Langley total 335, as I recall it. Then the NRL group, which came over with the VANGUARD project, presently are temporarily quartered in buildings adjacent to the Naval Research Laboratory.

Mr. THOMAS. How many are they?

Dr. GLENNAN. About 200.

Mr. THOMAS. 335 and 200, respectively. That is 535. That is about all of them.

Mr. ULMER. May I give you another breakdown on that. Some of the VANGUARD people that were transferred to the jurisdiction of the NASA are being paid from transferred VANGUARD funds. For that reason the total number of employees we have on duty, VANGUARD employees and those paid from NASA funds, will be higher than the 527 shown in this book.

Mr. THOMAS. They are all scattered around the District of Columbia and at your research centers?

Mr. ULMER. Yes; some are at NRL, some in a rented building in Silver Spring; some at the Langley Research Center; and also a small group at the Lewis Center in Cleveland.

PILOTLESS AIRCRAFT STATION

Mr. THOMAS. You have your Pilotless Aircraft Station, 97 this year against 250 for 1960. That is at Wallops Island, Va.?

Dr. GLENNAN. Yes, sir.

WESTERN COORDINATION OFFICE

Mr. THOMAS. Patrick, three and three. Western Coordination Office, four for 1959. I have been at the office once or twice. What use do you have for that office, much less for eight people in 1960?

Dr. DRYDEN. The NASA is entering into contracts with many companies in that area.

Mr. THOMAS. That man has no authority to enter into contracts.

Dr. DRYDEN. The four employees of that office, two men and two girls, are our agents for technical contacts with the west coast manufacturers. Some of our meetings of our advisory committees are held in that office. The staff makes periodic visits to the companies and to the educational institutions in the area to keep us informed.

Mr. THOMAS. The last time I was there that gentleman was having a lonesome time by himself. He had about as much utility as a third foot.

Dr. DRYDEN. I do not agree with you, sir. He is very useful to us. He is a very sharp reporter of things going on that are of interest to the NASA. Also, we send many technical teams out in this area and the staff at this office makes the necessary arrangements for their visits.

Mr. THOMAS. You have 10 installations. What about your laboratory in California?

Dr. GLENNAN. The Ames Research Center?

JET PROPULSION LABORATORY

Mr. THOMAS. Your jet propulsion laboratory.

Mr. ULMER. That is not shown on this breakdown because it is operated by contract and funds for its operation are provided under the "Research and development" appropriation. It is a line item shown on page 201 called "Support of JPL plant." Because it is a contract-operated laboratory, its funding is under the "Research and development" appropriation.

Mr. THOMAS. You do not give very much of a breakdown on that. You are seeking $9 million.

Mr. ULMER. The details are on page 226.

Mr. THOMAS. The $9 million is for buying land and for construction. What about personnel?

Mr. ULMER. That is shown on page 226.

Mr. THOMAS. I have written here: How many jobs? Why shouldn't the jet propulsion laboratory be transferred to the Cleveland Laboratory? You do not show the number of positions.

Dr. GLENNAN. There are 2,300 people at the jet propulsion laboratory. About half or a little more than half of those people are for the present operating on a missile systems contract with the Army, in connection with the development of the SERGEANT missile. The

SERGEANT effort is proposed to be phased out by the end of fiscal year 1960.

In addition the JPL wind tunnel installation is funded by the Air Force and the Army. They are the principal users of that facility and we have agreed to their continuing to fund its operation for 1 more fiscal year.

Mr. THOMAS. You say:

> The Executive order also provided for the transfer of $4,078,250 from the Department of Defense to the National Aeronautics and Space Administration. This amount represents the estimated cost of operating the transferred functions for the period January 1, 1959, to June 30, 1959.

That is 6 months.

Dr. GLENNAN. That contract is financed on a calendar year basis. We have paid for the six months from July 1, 1959, to December 31, 1959, out of 1959 NASA funds. The amounts requested for 1960 will finance the Jet Propulsion Laboratory through the calendar year 1960.

Mr. THOMAS. On page 228 I have a question mark. I have noted here liquid propellant research and development, about a million and a half dollars. I raise the question here in my own mind whether this work could not satisfactorily be done at the Cleveland Laboratory.

Anyway, is this all personnel costs? I am trying to develop the personnel costs. You are asking for $8,156,500. Is this personnel cost?

Dr. DRYDEN. There are personnel costs included in the figure but the personnel here are not Government employees. May I repeat this much of the background. JPL is a private laboratory. As far as their people are concerned, they are a private group.

Mr. THOMAS. Is the University of Southern California the operator?

Dr. DRYDEN. The California Institute of Technology. The Army and the Air Force built this installation at Government expense. The buildings and the facilities were built by the Army and the Air Force at Government expense. The laboratory has been operated under contract more recently by the Army—there has also been a little Air Force money in it from time to time—for the last 13 years.

Mr. THOMAS. What about your green sheets? We have kept up the university out there with the Atomic Energy Commission and now the NASA is doing the same thing.

Dr. DRYDEN. We do not break down green sheets for nongovernmental organizations. We are contracting with the university for the services of their jet propulsion laboratory.

BASIS FOR CONTRACT

Mr. THOMAS. What is the basis for the $8,156,000 contract? I know a lot of universities that would like to get a little of that easy business besides California.

Dr. DRYDEN. This is a Government installation built by the Department of Defense, and operated by the California Institute of Technology under contract.

Mr. THOMAS. What is the basis for the contract?

Dr. DRYDEN. The basis for the contract is the furnishing of certain items of work. There is a contract document which can be made available.

Mr. THOMAS. If you want $8 million, you had better make it available. Let us look at it.

Dr. DRYDEN. This is similar to the type of operation that has been going on at this laboratory for the Department of Defense for 13 years. It is similar to the way in which laboratories such as the Lincoln Laboratory are operated by contract with the Department of Defense. The JPL employees are not Government employees. We contract with the university for their services.

Mr. THOMAS. We are familiar with that type of arrangement but doubt its not being Government when the Government pays all the bills. We see a lot of them.

Dr. GLENNAN. In this situation in which we find ourselves of getting on with the job defined in the act, as required by the Congress and by the people, the matter of moving as rapidly as one reasonably could without incurring duplicate expenses inclined us toward this act of taking over a going organization whose principal interests were in——

Mr. THOMAS. Off the record.

(Discussion off the record.)

Dr. GLENNAN. We were not about to duplicate that.

Mr. THOMAS. You want to duplicate it now. You want $9 million for land and facilities. Off the record.

(Discussion off the record.)

Dr. GLENNAN. To provide this type of capability elsewhere will cost the same money and we would not have the capability in being. It would probably cost more money.

Mr. THOMAS. You mean California had a monopoly on this matter?

Dr. GLENNAN. No, sir. The laboratory is presently in being; 2,300 people live there. They work there. There are people whose basic interest is in space research. The fact that they started out years ago as a propulsion laboratory in rocket propulsion has led right into the development of these larger propulsion systems. They supported the Army Ballistic Missile Agency in practically all of the upper stage work.

Mr. THOMAS. The Army supported them.

Dr. GLENNAN. Dr. Dryden was speaking technically.

Dr. DRYDEN. The people at the California Institute of Technology were among the first to start any rocket development. They were often regarded as fools. A group of professors put up money of their own to begin the work. General Arnold saw the advantages and began to support them. They started the first jet-assisted takeoff rockets for aircraft. This laboratory played a major role in creating rocket propulsion in this country, and they are among the finest group of their kind. They are interested in space. They are a going concern. By taking them over we have literally saved several years.

Mr. BOLAND. Is this the only place where the Space Agency is interested in rocket propulsion?

Dr. DRYDEN. Rocket propulsion is one part of their activity.

Mr. BOLAND. You have 2,300 people working for Cal Tech out there. Half of these people are now engaged in the work on the SERGEANT missile.

Dr. GLENNAN. Finishing it up.

Mr. BOLAND. What are they going to do after you finish it?

Dr. DRYDEN. They have skills which NACA never had.

Mr. BOLAND. Do you not have it in other areas? This bothers me. We have these skills in other areas, too, at Ames or Edwards or the other places you are working.

Dr. GLENNAN. I think we would be guilty of the sort of thing that worries you except that this was an agency in being. We did not create it.

Mr. BOLAND. I understand.

Dr. GLENNAN. We are trying to make use of it most effectively for the Nation's space operations rather than going out and spending more money to build another laboratory and add more people.

Mr. BOLAND. You have to have this laboratory, it is something you need?

Dr. GLENNAN. They provide skills that complement the skills we have in our own NASA research centers at Ames, Lewis, and Langley. We have never in those centers been particularly strong in matters relating to electronics and guidance, or technology of this sort. We have in recent years, the last 10 years, had a considerable amount of interest in propellants of the same sort JPL have worked with but it is a complementary interest, not a duplication.

Mr. BOLAND. When is the SERGEANT missile going to be developed and when is the Army phasing out that operation?

Dr. GLENNAN. July 1960.

Mr. BOLAND. Half of the manpower complement is working on the SERGEANT missile—why do you need these?

Dr. GLENNAN. By that time our program will have grown to the point where we will probably need those people. My guess is they may have a somewhat smaller but not a substantially smaller complement. We are not about to try to find work just to fill up the laboratory.

Mr. BOLAND. I am sure you are not.

Dr. GLENNAN. We have been in business 8 months. We have grown from a $100 million organization to what we propose to be a $485 million organization.

Mr. BOLAND. That scares a lot of us.

Dr. GLENNAN. It scares a lot of people, but to get on with the job you laid before us we have to take this kind of step. It seems to me the most economical way to get it done and at the same time an exceedingly effective one. After all, these are the skills we need, these are the people who have spent the last 10 years in this business.

Mr. THOMAS. What is so urgent about it? Off the record.

(Discussion off the record.)

Dr. GLENNAN. We are trying to put some rationality into this situation. When you get a request for construction funds, we have not yet designed the building.

Mr. THOMAS. Stay with the personnel. We will go into construction in a minute. You will have enough to defend there when we get into it.

Dr. GLENNAN. It is all part of the same story of trying to do a rational, sensible, businesslike job.

Mr. THOMAS. We are not questioning yours and Dr. Dryden's sincerity or anything else. You will do a job. We are going to try to help you. We may hold you down a little bit.

How many super grade and special grade positions does your act give you? Did they give you 250 or 260?

Dr. GLENNAN. Two hundred and sixty.

Mr. THOMAS. How many have you filled?

Mr. ULMER. As of April 15 we had 141 of those 260 filled.

Mr. THOMAS. April 15. That is pretty current. They are not super grades as this committee knows them. We know a super grade as 16, 17, and 18. These are above 18. As far as the law is concerned, you have the authority to set the salary and the classification. You bypass the Civil Service Commission entirely.

Dr. GLENNAN. That is right.

Mr. THOMAS. You set the salary up to $19,000.

Dr. GLENNAN. On 250 jobs, yes, sir.

Mr. THOMAS. Break it down roughly as to the classification.

Dr. GLENNAN. Here is a statement of it.

Mr. THOMAS. We will insert the information in the record at this point.

(The information follows:)

List of positions established by the Administrator, NASA (pursuant to subsec. (2), sec. 203(b) of the National Aeronautics and Space Act of 1958—Public Law 85–568), as of May 27, 1959

Position title	*Location*
At $21,000:	
Associate Administrator	Headquarters.
Director of Aeronautical and Space Research	Do.
Director of Space Flight Development	Do.
Director of Program Planning and Evaluation	Do.
At $20,000:	
General Counsel, NASA	Headquarters.
Director, NASA Langley Research Center	Langley.[1]
Director, NASA Ames Research Center	Ames.[1]
Director, NASA Lewis Research Center	Lewis.[1]
At $19,000:	
Deputy Director of Aeronautical and Space Research	Headquarters.
Assistant Director of Research (aircraft operating problems, structures, and materials)	Do.
Assistant Director for Propulsion	Do.
Assistant Director for Space Sciences	Do.
Assistant Director for Advanced Technology	Do.
Assistant Director for Space Flight Operations	Do.
Assistant Director for Program Coordination	Do.
Assistant Director of Research (aerodynamics and flight mechanics)	Do.
Director of Business Administration	Do.
Assistant Administrator for Congressional Relations	Do.
Assistant to the Administrator	Do.
Scientist for Space Medicine Research	Do.
Scientist for Propulsion	Do.
Scientist for Vehicle Design	Do.
Associate Director, Langley Research Center	Langley
Associate Director, Ames Research Center	Ames
Associate Director, Lewis Research Center	Lewis
Assistant Director, Langley Research Center	Langley

[1] Locations, shown in abbreviated form, are shown at the end of the list.

List of positions established by the Administrator, NASA (pursuant to subsec. (2), sec. 203(b) of the National Aeronautics and Space Act of 1958—Public Law 85-568), as of May 27, 1959—Continued

Position title	*Location*
At $18,500:	
Assistant Director, Langley Research Center	Langley
Assistant Director, Ames Research Center	Ames
Assistant Director, Lewis Research Center	Lewis
Assistant Director, Lewis Research Center	Do.
Assistant Director, Goddard Space Center	Goddard [2]
At $18,000:	
Assistant Director, Langley Research Center	Langley
Chief, Supersonic Aerodynamics Division	Do.
Chief, High-Speed Research Division	Ames
Chief, Full-Scale and Flight Research Division	Do.
Chief, Propulsion Chemistry Division	Lewis
Chief, Fluid Systems Division	Do.
Assistant Director, Project Mercury	Goddard [2]
Chief, NASA High-Speed Flight Station	HSFS
At $17,500:	
Director of Public Information	Headquarters.
Scientist for guidance and control	Do.
Aeronautical research scientist, aerodynamics theory	Langley.
Chief, Dynamic Loads Division	Do.
Aeronautical research scientists, aerodynamics (2)	Ames.
Aeronautical research scientist, aerodynamics theory	Do.
Assistant Director, Tracking and Data Systems	Goddard.
Assistant Director, Space Science and Satellite Applications	Do.
Director, NASA Atlantic Missile Range Operations Office	AMR.
At $17,000:	
Technical Assistant to the Director of Space Flight Development	Headquarters.
Chief, space sciences programs	Do.
Chief, university contracting program	Do.
Chief, advanced technology programs	Do.
Chief, rocket vehicle development programs	Do.
Chief, Theoretical Mechanics Division	Langley.
Chief, Structures Research Division	Do.
Chief, Theoretical and Applied Research Division	Ames.
Chief, Nuclear Reactor Division	Lewis.
Chief, Materials and Structures Division	Do.
At $16,500:	
Chief, guidance and control program	Headquarters.
Chief, rocket booster development program	Do.
Chief, Structures and Materials Research Programs	Headquarters.
Assistant Chief, University Contracting Program	Do.
Chief, Power Plants Research Programs	Do.
Chief, Tracking Programs	Do.
Director of Procurement and Supply	Do.
Acting Secretary of the National Aeronautical and Space Council.	Do.
Chief, Planetary Sciences Programs	Do.
Technical Assistant to the Associate Director	Langley.
Chief, Propulsion Systems Division	Lewis.
Chief, Advanced Propulsion Division	Do.
Chief, Propulsion Aerodynamics Division	Do.
Chief, Theoretical Division	Goddard.
Chief, Satellite Applications Systems Division	Do.
Aeronautical Research Pilot	HSFS.

[2] Position part of Goddard Space Center program, but currently located at Langley.

List of positions established by the Administrator, NASA (pursuant to subsec. (2), sec. 203(b) of the National Aeronautics and Space Act of 1958—Public Law 85-568), as of May 27, 1959—Continued

Position title	*Location*
At $16,000:	
Assistant General Counsel	Headquarters.
Director of Personnel	Do.
Budget Officer	Do.
Chief, Manned Space Flight Program	Do.
Chief, Astronomy and Astrophysics Program	Do.
Aeronautical and Space Scientist, Manned Satellites	Do.
Chief of Technical Services	Langley.
Chief, Pilotless Aircraft Research Division	Do.
Chief, Unitary Plan Wind Tunnel Division	Do.
Chief, Flight Research Division	Do.
Chief, Full-Scale Research Division	Langley.
Aeronautical Research Scientist, Aerodynamics	Ames.
Chief, Unitary Plan Wind Tunnel Division	Do.
Chief, Instrument and Computing Research Division	Lewis.
Chief of Technical Services	Do.
Space and Aeronautical Scientist (technical assistant)	Goddard.[2]
Chief, Flight Systems Division	Do.[2]
Chief, Operations Division	Do.[2]
Chief, Engineering and Specifications Division	Do.[2]
Special Assistant to the Director, Project Mercury	Do.[2]
At $15,500:	
Assistant Chief, Aerodynamics and Flight Mechanics research programs	Headquarters.
Assistant Chief, Structures and Materials research programs	Do.
Chief, large engine rocket program	Do.
Chief, Space Propulsion and Auxiliary Power Unit program	Do.
Assistant to the Chairman, and Secretary to the Civilian-Military Liaison Committee	Do.
Chief, Nuclear Engine programs	Do.
Chief, Analysis and Requirements (propulsion programs)	Do.
Chief, Operating Problems research programs	Do.
Staff Scientist, Telemetry and Instrumentation	Do.
Chief, Stability Research Division	Langley.
Assistant Chief, Dynamic Loads Division	Do.
Assistant Chief, Full-Scale Research Division	Do.
Chief, Hydrodynamics Division	Do.
Aeronautical research scientists, stability and control	Do.
Aeronautical research pilot	Do.
Aeronautical research scientist, aerodynamics	Do.
Chief, Instrument Research Division	Do.
Assistant Chief, Pilotless Aircraft Research Division	Do.
Assistant Chief, Supersonic Aerodynamics Division	Do.
Assistant Chief, Full-Scale Research Division	Do.
Assistant Chief, Stability Research Division	Do.
Assistant Chief, Structures Research Division	Do.
Technical assistant to the Associate Director	Ames.
Aeronautical research scientist, aerodynamics	Do.
Do	Do.
Aeronautical research scientist, aerodynamics theory	Do.
Assistant Chief, High Speed Research Division	Do.
Assistant Chief, Full Scale and Flight Research Division	Do.
Aeronautical research scientist, aerodynamics	Do.
Do	Do.
Aeronautical research scientist, propulsion systems materials	Lewis.

[2] Position part of Goddard Space Center program, but currently located at Langley.

List of positions established by the Administrator, NASA (pursuant to subsec. (2), sec. 203(b) of the National Aeronautics and Space Act of 1958—Public Law 85-568), as of May 27, 1959—Continued

Position title	*Location*
At $15,500—Continued	
Assistant to the Director	Lewis.
Assistant Chief, Fluid Systems Division	Do.
Assistant Chief, Propulsion Aerodynamics Division	Do.
Assistant Chief, Propulsion Chemistry Division	Do.
Assistant Chief, Fluid Systems Division	Do.
Aeronautical research scientist, propulsion control theory	Do.
Associate Chief of Technical Services	Do.
Chief, Payload Systems Division	Goddard.[a]
Aeronautical Research Scientist, Propulsion Systems	Do.[a]
Technical Assistant to the Director, NASA Atlantic Missile Range Operations Office	AMR.
Chief, Research Divsion	HSFS.
At $15,000:	
Technical Assistant to the Deputy Administrator	Headquarters.
Aeronautical and Space Scientist (Manned Satellites)	Do.
Assistant General Counsel	Do.
Assistant General Counsel	Do.
Assistant General Counsel for Patent Matters	Do.
Director of International Cooperation	Do.
Chief, Communications Satellite Program	Do.
Space and Aeronautical Scientist, Nuclear Propulsion	Do.
Specialist, Advanced Propulsion Systems	Do.
Director of Security	Do.
Aeronautical Research Scientist, Stability and Control	Do.
Aeronautical Research Scientist, Aerodynamics	Do.
Staff Scientist, Computers and Celestial Mechanics	Do.
Head, Manned Orbiting Laboratory Program	Do.
Assistant Chief, Instrument Research Division	Langley.
Aeronautical Research Scientist, Instruments	Do.
Aeronautical Research Scientist, Structures	Do.
Assistant Chief, Dynamic Loads Division	Do.
Aeronautical Research Scientist, Stability and Control	Do.
Aeronautical Research Scientist, Aerodynamics	Do.
Aeronautical Research Scientist, Aerodynamics	Do.
Chief, Instrument Research Division	Ames.
Chief, Engineering Services Division	Ames.
Aeronautical Research Scientist, Combustion	Lewis.
Aeronautical Research Scientist, Compressors and Turbines	Do.
Assistant Chief, Propulsion Aerodynamics Division	Do.
Aeronautical Research Scientist, Aerodynamics Theory	Do.
Aeronautical Research Scientist, Rocket Propulsion	Do.
Aeronautical Research Scientist, Instruments	Do.
Aeronautical Research Scientist, Propulsion Control Theory	Do.
Aeronautical Research Scientist, Aerodynamics Theory	Do.
Chief, Facilities Engineering Division	Do.
Aeronautical Research Scientist, Rocket Propulsion	Do.
Chief, Space Sciences Division	Goddard.
Chief, Tracking Systems Division	Do.
Chief, Construction Engineering Division	Do.
Business Manager (Goddard)	Do.
Chief, NASA Wallops Station	Wallops.
Assistant Chief, Research Division	HSFS.
Chief, Instrumentation Division	Do.
Aeronautical Research Pilot	Do.
Aeronautical Research Scientist, Stability and Control	Do.

[a] Position part of Space Center programs, but currently is located at Lewis (Cleveland).

List of positions established by the Administrator, NASA (pursuant to subsec. (2), sec. 203(b) of the National Aeronautics and Space Act of 1958—Public Law 85-568), as of May 27, 1959—Continued

Position title	*Location*
At $14,500:	
Assistant to the Administrator	Headquarters.
Director of Management Analysis	Do.
Chief, Chemical Aeronomy Program	Do.
Assistant Chief, Theoretical Division	Goddard.
Associate Chief, Space Sciences Division	Do.
Associate Chief, Payload Systems Division	Do.
Space and Aeronautical Scientist, Meteorology	Do.
Space and Aeronautical Scientist, Astronomy	Do.
Space and Aeronautical Scientist, Physics of Atmosphere	Do.
Space and Aeronautical Scientist, Space Research Instrumentation	Do.
Space and Aeronautical Scientist, Ionosphere	Do.
Staff Scientist, Data Systems Planning	Do.
Space and Aeronautical Scientist, Instrumentation	Do.
Space and Aeronautical Scientist, Systems Integration	Do.

Note on locations:
Langley—NASA Langley Research Center, Langley Field, Va.
Ames—NASA Ames Research Center, Moffett Field, Calif.
Lewis—NASA Lewis Research Center, Cleveland, Ohio
Goddard—NASA Goddard Space Flight Center, Greenbelt, Md.
HSFS—NASA High-Speed Flight Station, Edwards, Calif.
AMR—NASA Atlantic Missile Range Operations Office, Patrick Air Force Base, Fla.
Wallops—NASA Wallops Station, Chincoteague, Va.

Mr. SIEPERT. I think we should give the latest figures we have on that. The data you have prepared as of April 15 does not take into account the culmination of about 3 months' study on what should be the additional use of these excepted positions.

Decisions were taken on that, I believe, as of the 17th of April, and I have information here which I think would answer the kind of questions you have.

Mr. THOMAS. Give it to us.

Mr. SIEPERT. 195 jobs have been approved. One hundred eighty-eight of these jobs are actually filled. The difference between these two represents name actions where the people have not actually reported to us yet.

In answer to the question of salary distribution, we have of the 188 filled jobs, 37 of these at rates of pay higher than the supergrade allocations to which you refer. They are at $18,000 or higher. The rest are at ranges between $14,000 and $17,500.

UNFILLED POSITIONS

Mr. THOMAS. How many unfilled jobs out of your 8,961 do you have now?

Mr. ULMER. 444 at the moment. This is again an April 15 date. On that date we had a total of 8,517 on board.

Mr. THOMAS. How many unfilled jobs do you have at headquarters?

Mr. ULMER. At headquarters on April 15 we had a total of 371 on duty. This figure will conflict somewhat with the figure you have been talking from on page 5 in that the urgency of getting some headquarters work underway required some adjustment in the complements of the various installations to provide additional positions

at headquarters. The 336 figure you see on page 5 has been changed and on April 15 we had on board 371 employees. This adjustment was made by appropriate reductions in the complements of other activities.

Mr. THOMAS. How many vacancies do you have at Langley?

Mr. ULMER. At Langley, approximately 60 vacancies.

Mr. THOMAS. How many at Ames?

Mr. ULMER. Forty-nine, sir.

Mr. THOMAS. Lewis?

Mr. ULMER. Ninety-six.

DISTRIBUTION OF SUPERGRADES

Mr. THOMAS. How are you distributing your supergrades?

Dr. GLENNAN. Distribution by activities or dollars?

Mr. THOMAS. By locations. How many in the national headquarters, Ames, Lewis, Langley, et cetera.

Mr. SIEPERT. I have a summary figure here. I will have to get the details. Of the total approved positions of 195, 69 of these are in headquarters and 126 are in the field centers.

Mr. THOMAS. Can you break down the 126?

Mr. SIEPERT. Yes, sir. I will have to count them off another sheet I have.

Mr. THOMAS. What could be the nature of the scientific work the gentlemen in headquarters are doing?

Dr. DRYDEN. Of course, all positions are not scientific. It was not restricted to scientific positions.

ADMINISTRATIVE SUPERGRADES

Mr. THOMAS. Doctor, you anticipate me. Tell me what urgency you have for administrative supergrades and how many do you have in that classification. The act says administrative, all right. It says scientific, engineering, and administrative personnel.

Dr. DRYDEN. The scientific ones are needed in connection with the planning——

Mr. THOMAS. No argument about that. What about administrative?

Dr. DRYDEN. Most people presenting papers are in that category from headquarters. In the administrative positions——

Mr. THOMAS. You would not call those gentlemen administrative personnel.

Dr. DRYDEN. For scientific research administration. They have to have scientific knowledge and be scientists, they have to know something about administration because they are the ones who estimate and plan the activities in the various areas. Dr. Newell is heading the group planning the activities in space science, and so on.

Mr. SIEPERT. In terms of a definition of administrative people as ones who have major executive responsibility but are not scientific program people—that is, not making scientific or technical judgments—the total figure would be 17.

Mr. THOMAS. Seventeen?

Mr. SIEPERT. Yes, sir.

Mr. THOMAS. What would be their duties and where are they located?

Mr. SIEPERT. My job as director of business administration, Mr. Ulmer's job as budget officer, the personnel officer of the entire NASA the individual who is the director of management analysis and studies, the director of procurement, the director of security, the head of public information, the business manager-designate for the Space Projects Center, and several positions in the general counsel's office for example. All of these are headquarters posts except the Space Projects business manager.

Mr. THOMAS. The General Services Administration will have five accounts where you folks will have one, and they do not have any such compensation. I am in favor of your getting paid but I do not know how you justify that.

PROMOTIONS WITHIN THE ORGANIZATION

How many of the 195 people are former employees promoted within the organization?

Mr. SIEPERT. 143 of the 195 spaces are for individuals whose last previous job was with the NACA.

Dr. DRYDEN. In many cases it is a new job with much broader responsibilities.

PERSONNEL TRANSFERRD FROM OTHER AGENCIES

Mr. THOMAS. How many were transferred to you?

Mr. SIEPERT. Forty positions are being filled by individuals from other Federal agencies.

Mr. THOMAS. Forty?

Mr. SIEPERT. That is right.

Mr. THOMAS. What agencies, the military, or what?

Dr. GLENNAN. Principally from the Department of the Navy.

Dr. DRYDEN. The VANGUARD Division is the principal group. Dr. Newell occupies one of the NASA excepted positions.

Mr. THOMAS. We will give it the broad generic term, they came from the military in various installations. What else?

Mr. SIEPERT. I would estimate three-quarters of the 40 came from the military. Others came from the Atomic Energy Commission, the Department of Health, Education, and Welfare, and other governmental agencies.

Mr. THOMAS. If they came from anybody other than the military, they had to come with your approval. The act says the Administrator must or shall set the compensation. I presume there might be some gentlemen's agreement between you folks and the Armed Forces, but if they come from the outside, that is something else. Most of your 195, you say 143 of them came from the old NACA.

Mr. SIEPERT. In each case they were personally approved by the Administrator after thorough justification.

Mr. THOMAS. I want to commend the Administrator on using good judgment in promoting these scientific people. If he is the one deserving the credit, I give it to him.

Dr. GLENNAN. I acted on advice of counsel, Dr. Dryden.

Mr. THOMAS. You can look "a fur piece" and not find any better.

Dr. GLENNAN. This has had a really thoroughgoing review every time we dealt with this problem. We take this as a trust.

RECRUITING

Mr. THOMAS. Are you having any trouble getting the types of employees you need?

Mr. ABBOTT. The report from the research centers is that the recruiting this year is in the most favorable climate we have had for many years. We are able to recruit and get top talent from the universities. It is going very well indeed.

Mr. SIEPERT. We should say that is a relative statement. When you are after good engineering talent, things never go easily. We made this year 186 actual visits to the campuses of these students. This is our best of all years, we think, to dramatize the kind of career the Government can offer in this new field of research. Yet we find that when we go to the colleges we are still offering initially about a thousand dollars a year below the going salary rate for the kind of people we are looking for. Having said that, let us say things are going quite well.

Mr. THOMAS. Here is a good, bright student from a class A engineering school. He has had no experience; he finishes with a B.S. degree in June. What does industry offer him?

Dr. GLENNAN. I can give an exact figure on that from my own institution. The average this year is $497 a month. That is $6,000 a year. All of the students in what we call the engineering sciences, which would be in fields very, very interesting to us, are going at $547 a month, which is about $6,600.

Mr. THOMAS. Quite a differential.

Mr. SIEPERT. That is from Case Institute. These general figures might be of interest. We are permitted to offer $5,430 for a B.S. degree. Our survey shows that industry at the moment is offering an average of $6,500 for this same type talent and for the top students they will go over $7,000 a year.

Because of this we have been earnestly pleading with the Civil Service Commission to restore to us in the field of aeronautical science at least the top of the grade entrance hiring. This was discontinued in the last pay adjustment. I think we can say we have had a sympathetic hearing from them in that they know what our problem is.

Mr. THOMAS. Did this last pay increase provide anything for scientific and engineering employment?

Mr. SIEPERT. It raised the general level of all classifications.

Mr. THOMAS. I am talking about scientific employees. It did not give them any special treatment?

Mr. SIEPERT. It gave one bit of special treatment. The law authorizes the Commission to hire people at grade 7 rather than at grade 5 without experience if they have exceptional talent. Another special exception permits us to pay transportation to a new employee's first duty station, which is a thing we have not had in the past. This is for all new employees.

AMES RESEARCH CENTER

Mr. THOMAS. Give us a breakdown and differentiate between the activities of the Langley, Ames and Lewis Research Centers. What are you doing at the Ames Center in California?

Dr. GLENNAN. I will ask Mr. Abbott to speak to that.

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Mr. ABBOTT. The Ames Research Center at Moffett Field, Calif., is purely an aerodynamics research center at the moment, primarily dealing with problems of high-speed aerodynamics, especially in the supersonic and hypersonic speed ranges. They are also studying many problems of space vehicles, particularly the reentry problem.

Mr. THOMAS. How many wind tunnels are there at Ames?

Mr. ABBOTT. That is a difficult question to answer, depending on your definition of a wind tunnel. We have a great many small jets which might or might not be called wind tunnels. The larger installations are much smaller in number, on the order of 12, I believe.

Mr. THOMAS. Are all your activities out there concerned with jet airplanes, or prop airplanes, or with missiles, or what?

Mr. ABBOTT. The activities at the Ames Center are concerned primarily with the problems of missiles and the reentry problems of spacecraft.

In addition to that, we do have a comparatively small effort going on in connection with vertical takeoff and landing aircraft. Also we are maintaining an effort at the present time on problems of supersonic cruise aircraft such as the B–70. This is a small effort compared with the problems of higher speeds where the missiles primarily are concerned.

DISTRIBUTION OF RESEARCH EFFORT

Mr. THOMAS. I understood you to say yesterday about 60 percent of all activities of the new agency still were dealing with airplanes; is that correct?

Mr. ABBOTT. I believe I said yesterday that 50 percent or more of our research activity is now applicable to spacecraft.

Mr. THOMAS. Not airplanes?

Mr. ABBOTT. Not airplanes.

Mr. THOMAS. What part of it is dealing with airplanes?

Mr. ABBOTT. Again this is a very difficult thing to say, Mr. Thomas, because the more fundamental the research gets the more difficult it is to tell whether we are dealing with an airplane, missile, or spacecraft.

Mr. THOMAS. You are not very helpful. You are a very practical man. Now, what we are trying to get at, you know what it is. Would you say it is 50–50?

Mr. ABBOTT. I would guess——

Mr. THOMAS. Airplanes and missiles.

Mr. ABBOTT. Airplanes and missiles and spacecraft. I would guess not less than 50 percent on airplanes and missiles.

Mr. THOMAS. Are you changing your activities any for 1960 over what you have been doing in 1956, 1957, 1958, and 1959?

Mr. ABBOTT. Yes, sir; there has been a greater change in the activities in the research centers in the last 2 years which is still continuing, than has taken place in the last 30 years.

Mr. THOMAS. It has reached to about 50 percent change in space activities, missiles, and whatnot; is that right?

Mr. ABBOTT. My answer is approximately 50 percent of the work is applicable to spacecraft. There is a great overlapping area so that for a great deal of the work, it is impossible to say whether it is applicable alone to spacecraft or applicable alone to missiles or applicable only to airplanes because it is applicable to all of them. If I

could take this example I spoke of before from another field, which I think is easy to see, research on rockets——

Mr. THOMAS. You speak of these three big laboratories and you have about $333 million extra.

Mr. ABBOTT. No, sir.

Mr. THOMAS. Roughly, how would you characterize that?

Mr. ABBOTT. The extra work in research and development is wholly, I would say, applicable to space.

Mr. THOMAS. One hundred percent?

Mr. ABBOTT. Yes.

RESEARCH AND DEVELOPMENT—SUPPORT OF NASA PLANT

Mr. THOMAS. How many personnel are included in that $333 million figure and what part of it will be done in your own NASA installations? I am trying to get an overall view.

Dr. DRYDEN. There is included in the R. & D. appropriation the 07, 08, and 09 items for the entire NASA plant——

Mr. THOMAS. What page is that?

Mr. ULMER. 201.

Mr. THOMAS. I did not overlook 201, but I am not sure it will give me what I am looking for.

Dr. DRYDEN. Support of NASA plant, $16,670,000. That is the first line.

Mr. THOMAS. Go ahead.

Dr. DRYDEN. $16,670,000 of the $333 million is the 07, 08, and 09 items associated with the NASA research centers and stations.

Mr. THOMAS. Where do you get that?

Mr. ULMER. That is explained on page 205.

Mr. THOMAS (reading:)

To provide funds for contractual services, repairs, alterations, minor construction, supplies, materials, and equipment required in the operation of all NASA activities.

I am talking about your personnel.

Dr. DRYDEN. There are no personnel costs in the $333 million.

Mr. THOMAS. You have services, repairs, alterations, minor construction, supplies, materials, equipment. What part is equipment? All of the descriptive words prior to the word "material" could mean personnel.

Dr. DRYDEN. Page 207 shows the makeup of the $16,670,000.

Mr. SIEPERT. The answer is, there are no NASA personal services in the R. & D. appropriation.

Mr. THOMAS. Are you sure about that?

Mr. ULMER. Yes, sir; all personal services for the entire agency are carried under the S. & E. appropriation.

Mr. THOMAS. Where will those contracts be performed? You have research contracts, $5 million; Government agencies, practically nil; non-Government facilities—it looks as though it is all done in your own shops.

Mr. ULMER. No, this work is done under contract.

Dr. DRYDEN. $16 million represents the items always considered under the 07, 08, and 09 accounts in connection with the research centers and other NASA installations.

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Mr. THOMAS. Where is the other $315 million going to be spent?

Dr. DRYDEN. All over the country.

Mr. THOMAS. By contract?

Dr. DRYDEN. By contract.

Mr. THOMAS. That is the answer. It is by contract. There is no personnel involved in it.

Mr. SIEPERT. All NASA personnel to manage these contracts in a technical and procurement sense are covered in "Salaries and expenses" appropriations and not in the R. & D. item.

Dr. GLENNAN. Is it not reasonable to point out that taking the salary complement at our research centers, taking the $16 million which we have set out here on the first line of page 201, and taking the construction equipment items, applying to those research centers, you could in essence break out, except for the headquarters staff, the costs that would be the equivalent to the old NACA costs.

Mr. THOMAS. That is what I am getting at. You have $333 million in the "Research and development" appropriation and you are not planning to spend any of that money inside your own plant?

Mr. ULMER. No, except for the $16 million support item I mentioned.

Mr. THOMAS. I am talking about personnelwise. If this $333 million is all for space, what in the world are you doing with the old NACA employees?

Dr. DRYDEN. Doing the kinds of things, research in ground facilities and in the air that they have been doing. The NACA functions were transferred. We are continuing the NACA types of activity. The NACA type of research supports the kind of program financed by the $333 million R. & D. program.

Mr. THOMAS. Are there no savings in administrative costs, no savings in any fields from the wedding of these two agencies? If one overlaps the other or is complementary to the other, it looks like there should be some administrative savings, but it goes up.

Dr. DRYDEN. It goes up because we have four times as large a program to manage and we have to support our space activities by research activities on the ground.

Mr. THOMAS. Your new activity is wholly space and you come up with a budget of $333 million, but you do not show any reduction at all in your old activities of NACA.

Dr. DRYDEN. Our activities in space started when sputnik was fired in October, 1957, an activity never existing in this country at all. This $333 million program is an entirely new type of activity for this country.

Mr. THOMAS. You have been shooting a few rockets at Wallops before.

Dr. DRYDEN. Not satellites. Satellites, lunar probes, deep space probes, meteorological satellites, communication satellites, manned flight in a satellite, the boosters necessary to do all these things, the technology to do these things, tracking systems—these activities did not exist in the world before October of 1957.

Mr. THOMAS. We have covered the broad outline. We all see what our thinking is.

Dr. DRYDEN. NACA was not abolished. It has been a very important agency involved in every missile and airplane that has ever

been built in this country. It got us leadership in these areas. We hope it will do the same in space. The people who are engaged in that are still required to carry on that function. The $333 million is a completely new type of activity never done in the world before October of 1957.

DISTRIBUTION OF SPECIAL AND SUPERGRADE POSITIONS

Mr. THOMAS. You are going to break down by location in your laboratories where you are going to put your excepted positions. Out of your 195, 143 came from the old NACA and you have 69 in your headquarters. Will you provide a breakdown by salary levels for all of your other locations?

Positions established by the administrator, NASA by salary and location (pursuant to subsection (2), section 203(b) of the National Aeronautics and Space Act of 1958—Public Law 85-568)

Salary	Headquarters	Langley	Ames	Lewis	High-Speed	Beltsville	Wallops	Patrick	Total
$21,000	4								4
$20,000	1	1	1	1					4
$19,000	13	2	1	1					17
$18,500		1	1	2		1			5
$18,000		2	2	2	1	1			8
$17,500	3	2	3			2		1	11
$17,000	5	2	1	2					10
$16,500	9	1		3	1	2			16
$16,000	6	5	2	2		5			20
$15,500	9	13	8	8	1	2		1	42
$15,000	15	7	2	10	4	4	1		43
$14,500	4					4			8
$14,000						7			7
Total	69	36	21	31	7	28	1	2	195

Mr. THOMAS. Are you sure you only have 444 unfilled jobs now?

Mr. ULMER. That is right, sir. They are being rapidly filled. It is not a question of not being able to fill them. It is a matter of being able to tailor our money to our recruiting schedule. They will be filled by the end of the year.

JUSTIFICATION DATA FOR SALARIES AND EXPENSES

Mr. THOMAS. Look at this personnel chart on page 6. Put page 7 giving a breakdown by object in here.

(The page follows:)

Estimates of appropriations—salaries and expenses, fiscal year 1960

		Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
01	Personal services:			
	Number of permanent positions (end of year)	7,892	8,961	9,988
	Annual cost of permanent positions (end of year)	$54,165,461	$63,178,541	$71,599,991
	Deduct lapses	3,307,597	4,877,046	2,749,856
	Net cost of permanent positions	50,857,864	58,301,495	68,850,135
	Intermittent employment	925	20,000	105,000
	Regular pay above 52-week base	206,102	242,235	550,715
	Overtime and nightwork differential	305,627	386,570	441,050
	Uniform allowances	5,855	8,600	10,600
	Reimbursable details		18,000	18,500
	Total personal services	51,376,373	58,976,900	69,976,000
02	Travel	402,178	1,212,500	3,181,000
03	Transportation of things	201,973	279,000	349,000
04	Communications services	224,348	438,450	3,827,000
05	Rents and utility services:			
	Electric power	6,349,831	7,052,900	7,669,000
	Other utilities	270,719	382,300	447,000
	Rentals	1,009,796	1,707,100	3,765,000
06	Printing and reproduction	119,476	139,140	210,500
07	Other contractual services:			
	Educational and scientific institutions	410,000	850,000	(*)
	Other Government agencies	205,284	285,330	*114,000
	Non-Government facilities	531,179	596,900	*935,000
	Repairs, alterations, and minor construction	1,119,757	1,055,270	*1,728,000
	Security investigations	118,015	180,000	350,000
	Federal life insurance	158,050	188,863	213,560
08	Supplies and materials	7,120,273	6,099,652	*8,283,000
09	Equipment	3,275,013	3,250,150	*5,610,000
11	Grants, subsidies, and contributions	3,141,148	3,740,275	4,420,540
13	Refunds, awards, and indemnities	2,079	5,000	6,000
15	Taxes and assessments	10,121	14,270	15,400
	Total	76,045,613	86,454,000	111,100,000
	*Funded under "Research and Development"			*−16,670,000
	Unobligated balance	30,596		
	Anticipated supplemental (classified pay act increase)		−3,354,000	
	Total allotment	76,076,209	83,100,000	94,430,000

Mr. THOMAS. The estimate of appropriations, "Salaries and expenses," for 1959 is on page 7. What is the difference between pages 7 and 8?

Mr. ULMER. Page 7 is the total sheet for the agency; page 8 covers NASA headquarters only.

Mr. THOMAS. Put page 8 in here, and also pages 9 through 13.

(The pages follow:)

Estimates of appropriations, salaries and expenses, fiscal year 1960

NASA HEADQUARTERS

		Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
01	Personal services:			
	Number of permanent positions (end of year)	170	336	486
	Annual cost of permanent positions (end of year)	$1,358,760	$2,678,304	$3,898,304
	Deduct lapses	121,043	552,804	338,704
	Net cost of permanent positions	1,237,717	2,125,500	3,559,600
	Intermittent employment	925	10,000	15,000
	Regular pay above 52-week base	5,145	10,400	30,100
	Overtime and nightwork differential	1,391	7,000	11,700
	Uniform allowances		100	100
	Reimbursable details		18,000	18,500
	Total, personal services	1,245,178	2,171,000	3,635,000
02	Travel	187,360	765,440	1,300,000
03	Transportation of things	447	9,000	2,000
04	Communications services	112,021	141,500	500,000
05	Rents and utility services:			
	Electric power			
	Other utilities			
	Rentals	3,552	5,000	4,000
06	Printing and reproduction	94,023	92,000	150,000
07	Other contractual services:			
	Educational and scientific institutions	410,000	850,000	(*)
	Other Government agencies	97,676	212,000	*10,000
	Non-Government facilities	37,175	109,500	*40,000
	Repairs, alterations, and minor construction	5,920	10,710	*14,000
	Security investigations	118,015	180,000	350,000
	Federal life insurance	3,936	8,500	12,000
08	Supplies and materials	32,006	65,000	*85,000
09	Equipment	34,884	130,700	*75,000
11	Grants, subsidies, and contributions	76,585	112,000	229,000
13	Refunds, awards, and indemnities	717	2,000	2,000
15	Taxes and assessments	280	500	1,000
	Total	2,459,775	4,864,850	6,409,000
	*Funded under "Research and development"			−*224,000
	Unobligated balance	4,926		
	Anticipated supplemental (Classified Pay Act increase)		−126,700	
	Total allotment	2,464,701	4,738,150	6,185,000

LANGLEY RESEARCH CENTER

01	Personal services:			
	Number of permanent positions (end of year)	3,213	3,333	3,333
	Annual cost of permanent positions (end of year)	$21,593,344	$22,834,525	$22,892,110
	Deduct lapses	1,277,871	755,175	249,310
	Net cost of permanent positions	20,315,473	22,079,350	22,642,800
	Intermittent employment			
	Regular pay above 52-week base	82,277	87,650	176,000
	Overtime and nightwork differential	76,213	101,000	81,000
	Uniform allowances	873	1,100	1,100
	Total personal services	20,474,836	22,269,100	22,900,900
02	Travel	93,259	189,000	200,000
03	Transportation of things	53,589	52,000	52,000
04	Communication services	31,927	33,000	33,000
05	Rents and utility services:			
	Electric power	1,697,181	1,885,000	2,035,000
	Other utilities			
	Rentals	620,961	789,000	864,000
	Operating and reproduction	16,327	24,500	25,500
07	Other contractual services:			
	Educational and scientific institutions			
	Other Government agencies	90,507	70,000	*100,000
	Non-Government facilities	156,248	160,000	*264,000
	Repairs, alterations, and minor construction	387,727	270,000	*580,000
	Security investigations			
	Federal life insurance	65,576	72,300	74,100

UNIVERSITY OF MICHIGAN LIBRARIES

Estimates of appropriations, salaries and expenses, fiscal year 1960—Continued

LANGLEY RESEARCH CENTER—Continued

	Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
08 Supplies and materials	$2,812,102	$2,509,400	*$2,800,000
09 Equipment	1,116,033	939,200	*1,320,000
11 Grants, subsidies, and contributions	1,264,121	1,418,000	*1,473,000
13 Refunds, awards, and indemnities	90	1,000	1,000
15 Taxes and assessments	1,127	1,500	1,500
Total	28,881,611	30,683,000	32,724,000
*Funded under "Research and development"			*−5,064,000
Unobligated balance	16,695		
Anticipated supplemental (Classified Pay Act increase)		−1,295,000	
Total allotment	28,898,306	29,388,000	27,660,000

AMES RESEARCH CENTER

01 Personal services:			
Number of permanent positions (end of year)	1,445	1,509	1,509
Annual cost of permanent positions (end of year)	$9,849,321	$10,553,600	$10,606,100
Deduct lapses	559,209	394,525	127,400
Net cost of permanent positions	9,290,112	10,159,075	10,478,700
Intermittent employment			
Regular pay above 52-week base	37,569	40,325	81,500
Overtime and nightwork differential	87,450	99,000	98,000
Uniform allowances	787	1,000	1,000
Total personal services	9,415,918	10,299,400	10,659,200
02 Travel	42,443	76,200	80,000
03 Transportation of things	20,609	25,000	26,000
04 Communications services	26,014	27,000	28,000
05 Rents and utility services:			
Electric power	2,503,097	2,557,000	2,650,000
Other utilities	71,865	81,000	90,000
Rentals	143,552	316,000	460,000
06 Printing and reproduction	5,343	12,000	7,000
07 Other contractual services:			
Educational and scientific institutions	803	500	*1,000
Other Government agencies	152,825	89,500	*130,000
Non-Government facilities	209,570	160,000	*455,000
Repairs, alterations, and minor construction			
Security investigations			
Federal life insurance	29,041	33,500	34,800
08 Supplies and materials	1,085,605	1,100,000	*1,700,000
09 Equipment	871,240	1,041,150	*1,350,000
11 Grants, subsidies, and contributions	564,486	662,800	674,000
13 Refunds, awards, and indemnities	266	500	1,000
15 Taxes and assessments	4,852	5,600	6,000
Total	15,147,529	16,487,150	18,352,000
*Funded under "Research and development"			−*3,636,000
Unobligated balance	4,038		
Anticipated supplemental (Classified Pay Act increase)		−603,000	
Total allotment	15,151,567	15,884,150	14,716,000

LEWIS RESEARCH CENTER

01 Personal services:			
Number of permanent positions (end of year)	2,678	2,828	2,828
Annual cost of permanent positions (end of year)	$18,863,868	$20,038,435	$20,089,935
Deduct lapses	1,199,533	747,036	196,035
Net cost of permanent positions	17,664,335	19,291,399	19,893,900
Intermittent employment			
Regular pay above 52-week base	71,776	76,302	154,500
Overtime and nightwork differential	100,282	113,000	113,000
Uniform alowances	4,151	5,500	5,500
Total personal services	17,840,544	19,486,201	20,166,900
02 Travel	53,117	75,370	150,000
03 Transportation of things	115,202	100,000	150,000
04 Communication services	41,873	40,000	45,000

Estimates of appropriations, salaries and expenses, fiscal year 1960—Continued

LEWIS RESEARCH CENTER—Continued

		Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
05	Rents and utility services:			
	Electric power	$2,096,579	$2,553,000	$2,902,000
	Other utilities	190,593	292,000	347,000
	Rentals	202,747	255,000	505,000
06	Printing and reproduction	2,766	4,000	4,000
07	Other contractual services:			
	Educational and scientific institutions			
	Other Government agencies	703	1,000	*1,000
	Non-Government facilities	182,040	195,000	*467,000
	Repairs, alterations, and minor construction	343,093	479,000	*532,900
	Security investigations			
	Federal life insurance	52,425	56,400	58,600
08	Supplies and materials	1,998,459	1,821,929	*2,829,860
09	Equipment	970,902	1,000,000	*2,299,700
11	Grants, subsidies, and contributions	1,097,664	1,244,100	1,271,040
13	Refunds, awards, and indemnities	876	1,000	1,000
15	Taxes and assessments	1,868	2,000	2,000
	Total	25,191,451	27,606,000	31,733,000
	*Funded under "Research and development"			*−6,130,460
	Unobligated balance	3,104		
	Anticipated supplemental (Classified Pay Act increase)		−1,202,000	
	Total allotment	25,194,555	26,404,000	25,602,540

HIGH-SPEED FLIGHT STATION

01	Personal services:			
	Number of permanent positions (end of year)	297	322	322
	Annual cost of permanent positions (end of year)	$1,976,662	$2,180,418	$2,191,818
	Deduct lapses	118,772	90,839	28,918
	Net cost of permanent positions	1,857,290	2,089,579	2,162,900
	Intermittent employment			
	Regular pay above 52-week base	7,328	8,355	16,900
	Overtime and nightwork differential	27,239	28,320	30,100
	Uniform allowances	44	100	100
	Total personal services	1,891,901	2,126,354	2,210,000
02	Travel	22,800	40,260	45,000
03	Transportation of things	4,275	5,000	4,000
04	Communications services	6,643	92,000	115,000
05	Rents and utility services:			
	Electric power	6,152	7,000	7,000
	Other utilities	8,261	9,300	10,000
	Rentals	38,956	71,000	82,000
06	Printing and reproduction	1,017	1,640	2,000
07	Other contractual services:			
	Educational and scientific institutions			
	Other Government agencies	889	900	*1,000
	Non-Government facilities	1,078	9,800	*4,000
	Repairs, alterations, and minor construction	36,992	66,400	*45,000
	Security investigations			
	Federal life insurance	5,301	5,650	6,000
08	Supplies and materials	195,325	170,346	*265,000
09	Equipment	235,261	86,200	*415,000
11	Grants, subsidies, and contributions	107,295	137,700	140,000
13	Refunds, awards, and indemnities	130	500	1,000
15	Taxes and assessments	1,994	3,050	2,000
	Total	2,564,270	2,833,100	3,354,000
	*Funded under "Research and development"			*−730,000
	Unobligated balance	1,833		
	Anticipated supplemental (Classified Pay Act increase)		−107,000	
	Total allotment	2,566,103	2,726,100	2,624,000

Estimates of appropriations, salaries and expenses, fiscal year 1960—Continued

SPACE PROJECTS CENTER

	Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
01 Personal services:			
Number of permanent positions (end of year)		527	1,247
Annual cost of permanent positions (end of year)		$4,230,869	$10,005,719
Deduct lapses		2,282,819	1,487,639
Net cost of permanent positions		1,948,050	8,518,080
Intermittent employment		10,000	90,000
Regular pay above 52-week base		16,650	76,970
Overtime and nightwork differential		23,300	80,000
Uniform allowances		800	1,000
Total personal services		1,998,800	8,766,050
02 Travel		55,000	1,195,000
03 Transportation of things		74,700	100,000
04 Communications services		97,400	2,103,000
05 Rents and utility services:			
Electric power			
Other utilities			
Rentals		271,000	1,860,000
06 Printing and reproduction		5,000	22,000
07 Other contractual services:			
Educational and scientific institutions			
Other Government agencies			
Non-Government facilities			*25,000
Repairs, alterations, and minor construction			
Security investigations			
Federal life insurance		10,200	23,500
08 Supplies and materials			*98,000
09 Equipment			*72,000
11 Grants, subsidies, and contributions		126,100	537,809
13 Refunds, awards, and indemnities			
15 Taxes and assessments		1,400	2,400
Total		2,639,600	14,744,750
*Funded under "Research and development"			*−195,000
Unobligated balance			
Anticipated supplemental (Classified Pay Act increase)			
Total allotment		2,639,600	14,549,750

Mr. THOMAS. Langley is on page 9, Ames is 10, Lewis is 11, the High Speed Station is 12. Where is that located?

Dr. GLENNAN. Edwards, Calif.

SPACE PROJECTS CENTER

Mr. THOMAS. The Space Projects Center is on page 13. Where is that located?

Dr. GLENNAN. Beltsville, Md.

Mr. THOMAS. Do you folks want to put everything right here in this Capital area and the rest in California? You have one less than a hundred miles from here. Everybody talks about if this country is bombed everybody will be trying to get out of the District of Columbia and off the west coast.

Dr. DRYDEN. This location was settled by the Congress last year.

Mr. THOMAS. I disagree with you. Congress did not settle anything. You did not submit it to this committee.

Dr. DRYDEN. It was submitted to this committee, sir. The Space Projects Center will be the control center for the worldwide tracking network. We have been told by the communications people that this is the best location for ease of renting circuits to all parts of the world.

We are also engaged in a very large contract business. Washington is the center of representation of contract people generally.

Mr. THOMAS. It is close to the seat of government.

Dr. DRYDEN. We have dealings with most agencies in government in the space program.

Mr. THOMAS. Central Intelligence moved out 50 or 60 miles. Somebody else moved out. Every time they get ready for a fire drill, they talk about concentration and the Capital being bombed. You have one of your centers down here about a hundred air miles.

Dr. DRYDEN. As far as I know, you could get this kind of communications net only adjoining a SAC base or here in the Washington area at any reasonable expense. According to the communications people, these are the areas where with minimum expense we can get this kind of circuitry. Otherwise we go into very large expenditures.

Mr. THOMAS. How much land do you have there?

Dr. GLENNAN. About 550 acres.

Dr. DRYDEN. It was Government-owned land at the Agricultural Research Center which was made available to us without cost. The location is to the east of the Baltimore-Washington Parkway.

Mr. THOMAS. How far is it from Washington?

Dr. DRYDEN. About 12 or 14 miles.

Mr. THOMAS. Could you not get it inside the District of Columbia? It would be more convenient for you.

Dr. DRYDEN. The Beltsville location is more useful than a District of Columbia location for the types of activity that we will be conducting at the center. I would like to put up this chart and emphasize again that you are this year dealing with a new agency which is an internationally operating agency as distinguished from the NACA which operated primarily within the United States. This affects our budget picture very greatly.

Mr. THOMAS. How do you mean, it affects the budget picture? You want to spend $30 million out there the first year. I guess next year you will want to spend $50 million.

Dr. DRYDEN. This chart shows the minitrack stations——

Mr. THOMAS. We hear a lot from the Office of Defense Mobilization. They speak of decentralization, moving Government agencies out of Washington. You are going to build a very sensitive one, a research installation here.

Dr. DRYDEN. This network of stations was built in connection with the VANGUARD project. The Beltsville Center will house the communications equipment required in connection with our worldwide launching and tracking operations.

You are not dealing with NACA. The NASA is a new agency engaged in worldwide operations formerly——

Mr. THOMAS. What does that have to do with putting it in the District of Columbia?

Dr. DRYDEN. Many of the center's functions are now being performed in scattered locations, at the Naval Research Laboratory for example. We are going to group these functions at the Beltsville Center. We also have the core of the people here from the transferred VANGUARD project, as you recall.

Mr. THOMAS. At the salaries you are offering to pay, I imagine you can get people to come with you. Is that the reason for putting it here, for the convenience of the people?

Dr. DRYDEN. I am reviewing the considerations which led to the selection of the Beltsville site. The Congress authorized the construction of the center in the vicinity of Washington, D.C. As far as we are concerned, that decision has been made; the buildings are under construction there now.

Mr. THOMAS. You mean the decision to put it out here near the District of Columbia?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. Did Congress give you the money at the same time?

Dr. DRYDEN. The initial construction funds were provided in Public Law 85–766.

Mr. THOMAS. You already have the money. What are you looking for now if you have the money? Build it.

Dr. DRYDEN. We have money for the initial construction only.

Mr. THOMAS. Leave out that word "initial."

Dr. GLENNAN. $14 million is our 1960 request.

Mr. THOMAS. If you have all you need——

Dr. DRYDEN. Without this, the whole program is worthless. You do all this to get information from these stations around the world, you get the information into a center, work up the scientific results and get the information back. If you do not do this, the rest of it is fireworks.

Mr. THOMAS. You acted on your own. You are on your own. You were advised a long time ago.

JUSTIFICATION DATA FOR SALARIES AND EXPENSES

We will put pages 14 through 17 in the record.

(The pages referred to follow:)

Estimates of appropriations—Salaries and expenses, fiscal year 1960

PILOTLESS AIRCRAFT STATION

		Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
01	Personal services:			
	Number of permanent positions (end of year)	83	97	250
	Annual cost of permanent positions (end of year)	$466,436	$566,470	$1,793,470
	Deduct lapses	23,051	35,730	314,070
	Net cost of permanent positions	443,385	530,740	1,479,400
	Intermittent employment			
	Regular pay above 52-week base	1,785	2,180	13,800
	Overtime and night-work differential	13,052	14,950	27,000
	Uniform allowances			1,800
	Total personal services	458,222	547,870	1,522,000
02	Travel	946	5,000	200,000
03	Transportation of things	7,851	13,000	15,000
04	Communications services	4,538	5,000	996,000
05	Rents and utility services:			
	Electric power	46,822	50,900	75,000
	Other utilities			
	Rentals	28	100	50,000
06	Printing and reproduction			
07	Other contractual services:			
	Educational and scientific institutions			
	Other Government agencies	14,706	930	*1,000
	Non-Government facilities	1,813	33,000	*5,000
	Repairs, alterations, and minor construction	136,022	67,500	*100,000
	Security investigations			
	Federal life insurance	1,501	1,800	3,500
0	Supplies and materials	996,385	432,100	*500,000
09	Equipment	46,345	50,000	*70,000
11	Grants, subsidies, and contributions	27,846	34,500	88,000
13	Refunds, awards, and indemnities			
15	Taxes and assessments		220	500
	Total	1,743,025	1,241,920	3,626,000
	Funded under "Research and development"*			*−676,000
	Unobligated balance			
	Anticipated supplemental (Classified Pay Act increase)		−14,700	
	Total allotment	1,743,025	1,227,220	2,950,000

PATRICK OFFICE

01	Personal services:			
	Number of permanent positions (end of year)		3	3
	Annual cost of permanent positions (end of year)		$37,950	$38,100
	Deduct lapses		18,100	400
	Net cost of permanent positions		19,850	37,700
	Intermittent employment			
	Regular pay above 52-week base		150	300
	Overtime and nightwork differential			250
	Uniform allowances			
	Total personal services		20,000	38,250
02	Travel		3,000	5,000
03	Transportation of things		300	
04	Communications services		1,200	4,000
05	Rents and utility services:			
	Electric power			
	Other utilities			
	Rentals			
06	Printing and reproduction			
07	Other contractual services:			
	Educational and scientific institutions			
	Other Government agencies			
	Non-Government facilities		100	
	Repairs, alterations, and minor construction			
	Security investigations			
	Federal life insurance		200	500
08	Supplies and materials		300	*2,000
09	Equipment		1,000	*3,000
11	Grants, subsidies, and contributions		1,300	2,500

Estimates of appropriations—Salaries and expenses, fiscal year 1960—Continued

PATRICK OFFICE—Continued

	Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
13 Refunds, awards, and indemnities			
15 Taxes and assessments			
Total		$27,400	$55,250
Funded under "Research and development"*			*—5,000
Unobligated balance			
Anticipated supplemental (Classified Pay Act increase)			
Total allotment		27,400	50,250

WESTERN COORDINATION OFFICE

01 Personal services:			
Number of permanent positions (end of year)	4	4	8
Annual cost of permanent positions (end of year)	$39,060	$39,210	$65,525
Deduct lapses	6,044	20	7,125
Net cost of permanent positions	33,016	39,190	58,400
Intermittent employment			
Regular pay above 52-week base	150	151	500
Overtime and night-work differential			
Uniform allowances			
Total personal services	33,166	39,341	58,900
02 Travel	1,421	2,300	5,000
03 Transportation of things			
04 Communications services	1,230	1,200	2,700
05 Rents and utility services:			
Electric power			
Other utilities			
Rentals			
06 Printing and reproduction			
07 Other contractual services:			
Educational and scientific institutions			
Other Government agencies			
Non-Government facilities			
Repairs, alterations, and minor construction	335	1,560	*1,000
Security investigations			
Federal life insurance	214	254	500
08 Supplies and materials	346	500	*3,000
09 Equipment	348	1,900	*5,000
11 Grants, subsidies, and contributions	2,110	2,550	3,900
13 Refunds, awards, and indemnities			
15 Taxes and assessments			
Total	39,170	49,605	80,000
Funded under "Research and development"*			*—9,000
Unobligated balance			
Anticipated supplemental (Classified Pay Act increase)		−3,800	
Total allotment	39,170	45,805	71,000

WRIGHT-PATTERSON LIAISON OFFICE

01 Personal services:			
Number of permanent positions (end of year)	2	2	2
Annual cost of permanent positions (end of year)	$18,610	$18,760	$18,910
Deduct lapses	2,074	+2	255
Net cost of permanent positions	16,536	18,762	18,655
Intermittent employment			
Regular pay above 52-week base	72	72	145
Overtime and night-work differential			
Uniform allowances			
Total personal services	16,608	18,834	18,800
02 Travel	832	930	1,000
03 Transportation of things			
04 Communications services	102	150	300
05 Rents and utility services:			
Electric power			
Other utilities			
Rentals			
Printing and reproduction			

Estimates of appropriations—Salaries and expenses, fiscal year 1960—Continued

WRIGHT-PATTERSON LIAISON OFFICE—Continued

	Fiscal year 1958, obligated	Fiscal year 1959, estimated	Fiscal year 1960, estimated
07 Other contractual services:			
Educational and scientific institutions			
Other Government agencies			
Non-Government facilities			
Repairs, alterations, and minor construction	$98	$100	*100
Security investigations			
Federal life insurance	56	59	60
08 Supplies and materials	45	77	*140
09 Equipment			*300
11 Grants, subsidies, and contributions	1,041	1,225	1,300
13 Refunds, awards, and indemnities			
15 Taxes and assessments			
Total	18,782	21,375	22,000
Funded under "Research and development" *			*−540
Unobligated balance			
Anticipated supplemental (Classified Pay Act increase)		−1,800	
Total allotment	18,782	19,575	21,460

RESEARCH AND DEVELOPMENT

Mr. THOMAS. Let us look at "Research and development." Put your cover sheets in here, pages 201 through 205.

(The material referred to follows:)

Research and development programs, fiscal years 1959 and 1960

Program	Fiscal year 1959		Fiscal year 1960 estimates
	Allotments	Supplemental	
Aircraft, missile, and spacecraft research:			
Support of NASA plant	$588,800		$16,670,000
Support of JPL plant	8,156,500		8,156,500
Research contracts	3,000,000		5,200,000
Scientific investigations in space:			
Sounding rockets	5,000,000		10,000,000
Scientific satellites	23,252,000		22,800,000
Lunar probes	7,720,750		7,140,000
Deep-space probes	17,791,000		6,803,500
Vanguard program	25,541,282		
Satellite applications investigations:			
Meteorology	2,500,000		10,800,000
Communications	3,460,000		4,700,000
Space operations technology:			
Manned space flight	37,661,200	$20,750,000	70,000,000
Space rendezvous techniques			3,000,000
Space propulsion technology:			
Solid propellent rockets	700,000		3,000,000
High-energy propellent rockets	7,000,000		5,000,000
1 to 1.5-million-pound-thrust single-chamber engine	10,000,000		30,200,000
Nuclear rocket engines	4,500,000		8,000,000
Space engines	300,000		3,000,000
Auxiliary power units	500,000		3,000,000
Space systems technology:			
Advanced vehicle systems	500,000		1,500,000
Booster recovery systems	500,000		1,500,000
Orbiting space laboratories			2,000,000
Supporting activities:			
Tracking and data acquisition	3,300,000		11,500,000
Vehicle development:			
Scout	6,048,000		2,000,000
Delta	13,800,000		13,300,000
Vega	22,800,000		42,800,000
Centaur			41,000,000
Total, research and development	204,619,532	20,750,000	333,070,000

Research and development programs, fiscal year 1959

Program	Scientific and technical studies	Prototypes and operational hardware	Operations and technical services	Supplies, equipment, and alterations	Total
Aircraft, missile, and spacecraft research:					
Support of NASA plant			$153,000	$435,800	$588,800
Support of JPL plant	$2,156,500	$100,000	3,000,000	2,900,000	8,156,500
Research contracts	3,000,000				3,000,000
Scientific investigations in space:					
Sounding rockets	300,000	3,000,000	700,000	1,000,000	5,000,000
Scientific satellites	1,000,000	18,510,000	2,742,000	1,000,000	23,252,000
Lunar probes	875,000	6,310,750	285,000	250,000	7,720,750
Deep-space probes	1,640,000	15,391,000	600,000	160,000	17,791,000
Vanguard program [1]					25,541,282
Satellite applications investigations:					
Meteorology	1,250,000	850,000	200,000	200,000	2,500,000
Communications	160,000	3,150,000	100,000	50,000	3,460,000
Space operations technology:					
Manned space flight	700,000	33,361,200	1,700,000	1,900,000	37,661,200
Space rendezvous techniques					
Space propulsion technology:					
Solid propellent rockets	100,000	400,000		200,000	700,000
High-energy propellant rockets	2,000,000	5,000,000			7,000,000
1 to 1.5-million-pound thrust single chamber engine		10,000,000			10,000,000
Nuclear rocket engines	1,000,000	3,300,000		200,000	4,500,000
Space engines	200,000	100,000			300,000
Auxiliary power units	200,000	300,000			500,000
Space systems technology:					
Advanced vehicle systems	500,000				500,000
Booster recovery systems	500,000				500,000
Orbiting space laboratories					
Supporting activities: Tracking and data acquisition	300,000	600,000	2,000,000	400,000	3,300,000
Vehicle development:					
Scout		5,750,000		298,000	6,048,000
Delta	500,000	13,300,000			13,800,000
Vega	2,000,000	20,800,000			22,800,000
Centaur					
Total, research and development	18,381,500	140,222,950	11,480,000	8,993,809	204,619,532

[1] Functional breakdown not available.

Functional breakdown—Research and development, fiscal year 1959 supplemental

Program	Contracts for—				Total
	Scientific and technical studies	Prototypes and operational hardware	Operations and technical services	Supplies, equipment, repairs, and alterations	
Aircraft, missile, and spacecraft research:					
Support of NASA plant					
Support of JPL plant					
Research contracts					
Scientific investigations in space:					
Sounding rockets					
Scientific satellites					
Lunar probes					
Deep-space probes					
Vanguard program					
Satellite applications investigations:					
Meteorology					
Communications					
Space operations technology:					
Manned space flight		$20,000,000		$750,000	$20,750,000
Space rendezvous techniques					
Space propulsion technology:					
Solid propellant rockets					
High-energy propellant rockets					
1 to 1.5 million-pound-thrust single-chamber engine					
Nuclear rocket engines					
Space engines					
Auxiliary power units					
Space systems technology:					
Advanced vehicle systems					
Booster recovery systems					
Orbiting space laboratories					
Supporting activities: Tracking and data acquisition					
Vehicle Development:					
Scout					
Delta					
Vega					
Centaur					
Total, research and development		20,000,000		750,000	20,750,000

Research and development programs—fiscal year 1960

Program	Scientific and technical studies	Prototypes and operational hardware	Operations and technical services	Supplies, equipment, and alterations	Total
Aircraft, missile, and spacecraft research:					
Support of NASA plant			$1,049,000	$15,621,000	$16,670,000
Support of JPL plant	$2,156,500	$100,000	3,000,000	2,900,000	8,156,500
Research contracts	5,200,000				5,200,000
Scientific investigations in space:					
Sounding rockets	500,000	6,000,000	1,500,000	2,000,000	10,000,000
Scientific satellites	3,000,000	10,150,000	6,650,000	3,000,000	22,800,000
Lunar probes	1,800,000	3,100,000	1,240,000	1,000,000	7,140,000
Deep-space probes	1,650,000	3,653,500	1,000,000	500,000	6,803,500
Vanguard program					
Satellite applications investigations:					
Meteorology	1,200,000	6,300,000	2,500,000	800,000	10,800,000
Communications	1,500,000	1,100,000	1,500,000	600,000	4,700,000
Space operations technology:					
Manned space flight	1,300,000	49,700,000	13,000,000	6,000,000	70,000,000
Space rendezvous techniques	1,000,000	1,500,000		500,000	3,000,000
Space propulsion technology:					
Solid propellent rockets	800,000	1,800,000		400,000	3,000,000
High-energy propellent rockets	3,400,000	1,600,000			5,000,000
1-million pound thrust single chamber engine		30,200,000			30,200,000
Nuclear rocket engines	2,000,000	5,500,000	200,000	300,000	8,000,000
Space engines	1,000,000	1,800,000		200,000	3,000,000
Auxiliary power units	300,000	2,550,000		150,000	3,000,000
Space systems technology:					
Advanced vehicle systems	1,200,000			300,000	1,500,000
Booster recovery systems	1,200,000			300,000	1,500,000
Orbiting space laboratories	900,000	900,000		200,000	2,000,000
Supporting activities: Tracking and data acquisition	800,000	1,500,000	7,500,000	1,700,000	11,500,000
Vehicle development:					
Scout		800,000	1,000,000	200,000	2,000,000
Delta		8,300,000	5,000,000		13,300,000
Vega	4,500,000	38,300,000			42,800,000
Centaur	4,000,000	37,000,000			41,000,000
Total, research and development	39,406,500	211,853,500	45,139,000	36,671,000	333,070,000

OPERATIONAL SUPPORT OF NASA PLANT

Fiscal year 1959	$11,726,102
Fiscal year 1960	16,670,000

1. Objectives

To provide funds for contractual services, repairs, alterations, minor construction, supplies, materials, and equipment required in the operation of all NASA activities.

2. Justification

Prior to the establishment of the NASA, all funds appropriated to the NACA were provided under two appropriation titles: "Salaries and expenses," and "Construction and equipment." The "Salaries and expenses" appropriation provided funds for the operation of all NACA activities and was a single-year appropriation. The funds appropriated under "Construction and equipment" were no-year funds and provided for the construction, modernization, and equipment of the NACA physical plant.

A review of the legislative history of the National Aeronautics and Space Act of 1958, Public Law 85-568, approved July 29, 1958, indicates the intention of the Congress to retain within the "Salaries and expenses" appropriation title only those items normally required to be appropriated on an annual basis, such as personal services, electric power, life insurance, retirement contributions, and similar items. The initial NASA fiscal year 1959 appropriation was approved on this basis. Flexibility in the programing of research activities was provided by including requirements for contractual services, supplies, materials, equipment, and similar items involved in plant maintenance and operation under the "Research and development" appropriation. Requirements for these purposes are grouped under the program heading entitled "Operational Support of NASA Plant."

AIRCRAFT, MISSILE, AND SPACECRAFT RESEARCH

SUPPORT OF NASA PLANT

Mr. THOMAS. Let us go down to a breakdown. Let us look at the support of NASA plant, $16,700,000, on page 205. This is to provide funds for contractual services, repairs, alterations, minor supplies, materials, equipment required in operation of all NASA activities. By what stretch of imagination did you come up with that figure of $16,670,000? How did you arrive at that?

Mr. ULMER. This is a budget projection based on our need for these types of items over many years. We have come before you for many years defending our requests for contractual services, supplies, and equipment. The $16,670,000 figure is the sum total of those same needs for the fiscal year 1960. The breakdown is shown on page 207. On that page we show the comparable figures for 1959. For example, repairs and alterations in 1959, $1,175,270——

Mr. THOMAS. Is this the old NACA activity or is this the new activity?

Mr. ULMER. The in-house activity, the old NACA activity.

Mr. THOMAS. I understood a while ago it was all for new activities, no personnel in it at all.

Mr. ULMER. These funds are not for personal services. These funds are for contractual services, supplies, and equipment.

Mr. THOMAS. Is it for new activities?

Mr. ULMER. For all NASA installations. Most of it goes to the Langley, Ames, and Lewis Research Centers. There is detail on later pages showing the breakdown.

Mr. THOMAS. You have machine shop and metal fabrication services, repairs, and alterations to the headquarters; you have supplies, materials, and equipment. I have read all through this, but it looks as though you pulled these figures out of the air. Recurring equipment on page 210, $1,975,700:

This class of equipment is made up of those categories of items for which the yearly dollar requirement may be predicted with reasonable accuracy but in which the individual items cannot be specified in advance.

What does that mean?

Mr. ULMER. This is the type of equipment we buy every year at our research centers. Turn to page 221, if you will. We have broken this down into types of equipment. Every year we need electrical and electronic equipment, mechanical and hydraulic equipment, and photographic equipment. These are the types of equipment we request every year.

On page 221 we have given you the amounts we have obligated for those purposes during the current fiscal year and our estimate for 1960. This is the same type of equipment we have defended year after year.

Mr. THOMAS. For new equipment you say:

This category comprises estimates of equipment needs which may be defined with reasonable accuracy and which can normally be predicted a year in advance. Significant changes in research activities are requiring the procurement of more costly equipment items. The rapid shifting of research emphasis from turbojet engines to rocket engines will require specialized equipment in connection with investigations on rocket control and guidance systems. Additional equipment will be required to cover expanding research effort associated with nuclear propulsion systems. The increase in the number of launchings of unrecoverable research missiles will result in a higher rate of attrition for instrumentation than previously experienced. Requirements for tracking and computer components in connection with flight research on the X–15 spacecraft will increase for the budget year. The estimates also include increased needs for extending existing data recording and computing systems, ground tracking facilities, and other specialized equipment items for materials and fuels investigations. The equipment needs for the fiscal years 1959 and 1960 are summarized on the six pages following the breakdown for supplies and materials.

Mr. ULMER. Page 222.

Mr. THOMAS. You follow that with three or four pages and lump it all in there. When you get through, I do not know anything about it and I doubt if you do.

Dr. GLENNAN. If you look at page 222, you will find the detail.

Mr. THOMAS. I have an item on page 213, painting exterior of unitary plan tunnel. That is $28,000. Is that with gold or silver paint?

Mr. ULMER. You are reading from a list of contractual services for repairs and alterations. The breakdown of new equipment is shown on page 222.

Mr. THOMAS. That is less definite than what I am reading from now.

Mr. ULMER. I will give you more detail.

Mr. THOMAS. I am talking about what is before us. What is definite about page 222? You have round figures and speak in broad terms.

Mr. ULMER. Following page 222 is a detailed list of the requirements for new scientific and research equipment. That breakdown totals $2,776,000. That is the big bulk of the $3 million item for new equipment. The list shows the specific items required for this purpose.

Dr. GLENNAN. Mr. Chairman, this breakdown is much more detailed than anything I have seen before. This is the kind of equipment without which you do not keep a laboratory moving ahead. It is basic to the nature of the work.

Mr. THOMAS. What is your inventory now at the old NACA installations?

Mr. ULMER. The total plant value is about $400 million, Mr. Thomas. That figure includes all facilities and equipment. I can give you a breakdown, if you wish.

Mr. THOMAS. What is your stock?

Mr. ULMER. You have reference to supply items?

Mr. THOMAS. Yes, sir.

Mr. ULMER. I would have to estimate that. I would say it averages between $1.5 and $2 million per year, excluding rockets and missiles.

Mr. THOMAS. What is the turnover, annually?

Mr. ULMER. In supplies it runs between $6 and $7 million a year, sir, again excluding rockets and missiles.

Mr. THOMAS. Are these equipment items decreasing in cost, or are they going up in cost, or are they stable? In other words, what is the market picture on them?

Mr. ULMER. I think the prices are fairly stable, Mr. Thomas, but the complexity is increasing and for that reason the cost is increasing.

Mr. THOMAS. Well, I have been through your laboratories a good many times and have seen the different types of equipment which you have. Frankly, I do not know whether you turn it over or not or whether you are getting the proper utilization out of it.

Do you have anyone to look over your equipment?

Mr. ULMER. Yes, sir, we do. At each installation no new item of equipment is procured until all of our current stock has been checked to see whether we can get the item by modifying an existing piece of equipment.

Mr. THOMAS. What type and how much computing equipment are you going to buy? You installed some such type equipment down at Langley last year; did you not?

Mr. ULMER. We are building a new data reduction center which includes computing equipment.

Mr. THOMAS. How much was allocated for that?

Mr. ULMER. I believe $3.5 million.

Mr. THOMAS. How much are you going to buy?

Mr. ULMER. There is an item under our "Construction and equipment" appropriation for the Ames Laboratory of a data reduction center in the amount of $2.5 million.

Mr. THOMAS. Well, you are going to have that equipment at Ames and at Langley. Do you plan to have such equipment any place else?

Mr. ULMER. We have it at all installations. This is a necessity in this kind of business, Mr. Thomas.

Dr. DRYDEN. We have changed very much from pencils and paper in the handling of numbers.

Mr. THOMAS. This new equipment at Langley is not in operation as yet?

Mr. ULMER. No, sir; we have a great deal of computing equipment at Langley but it has not yet been centralized at the new facility now under construction.

Dr. GLENNAN. All of this makes more effective use of the employees which we have.

SUPPORT OF JPL PLANT

Mr. THOMAS. At this point in the record we will insert pages 226 through 229 of the justifications having to do with the JPL plant.

(The pages referred to follows:)

SUPPORT OF JET PROPULSION LABORATORY PLANT

Fiscal year 1959	$8,156,500
Fiscal year 1960	8,156,500

1. Objectives

The Jet Propulsion Laboratory, operated by the California Institute of Technology at Pasadena, Calif., under control and funding by the Department of the Army, has been carrying on research in many areas associated with the development of missiles and space vehicles. Some of this work had specific military application; a large portion of the work was more general in nature. The technical knowledge resulting from the work is applied to the design, propulsion, operation, and guidance of improved missiles and space vehicles.

2. History of transfer to National Aeronautics and Space Administration

The National Aeronautics and Space Act of 1959 (Public Law 85-568) gave the President authority to transfer to the newly established National Aeronautics and Space Administration "any functions—of any other department or agency of the United States—which relate primarily to the functions, powers, and duties of the Administration as prescribed by section 203 of this act." Pursuant to this authority, the President issued Executive Order 10793, dated December 3, 1958, which transferred "those functions (including powers, duties, activities, and parts of functions) of the Department of the Army or of any officer or organizational entity thereof which are now being performed at the Jet Propulsion Laboratory of the California Institute of Technology, near Pasadena, Calif. (hereinafter referred to as the Laboratory), except so much thereof as relates primarily to military operations and weapon system development programs" to the National Aeronautics and Space Administration. The Executive order also provided for the transfer of $4,078,250 from the Department of Defense to the National Aeronautics and Space Administration. This amount represents the estimated cost of operating the transferred functions for the period January 1, 1959, to June 30, 1959.

On December 3, 1958, an agreement entitled "Cooperative Agreement on the Jet Propulsion Laboratory Between the National Aeronautics and Space Administration and the Department of the Army" was signed by the Administrator, NASA, and the Secretary of the Army. This agreement defined the policies and procedures to be followed in carrying out the details of the transfer. Implementation of the agreement is now in progress.

On December 18, 1958, NASA Order No. HS-41 was issued to the Jet Propulsion Laboratory providing authority and funds for the continuation of this work.

3. Program phasing

The NASA plans to carry on the transferred functions of the Jet Propulsion Laboratory in accordance with the current research program. Due to the calendar year funding method for the Jet Propulsion Laboratory now in use funds for the period January 1, 1959, to December 31, 1959, will be supplied from the NASA's fiscal year 1959 appropriation for "Research and development" ($8,156,500) and funds for the period January 1, 1960, to December 31, 1960, will be supplied from the fiscal year 1960 appropriation ($8,156,500). During 1959 the research program of the Jet Propulsion Laboratory will be examined and reviewed to determine the areas where changes in emphasis may be required.

4. Program costs

		Fiscal year 1959	Fiscal year 1960
Guidance and control		$900,000	$900,000
Extreme range communications	$300,000		
Physical and electrochemical research in electronics	210,000		
Guidance component research	220,000		
Telemetering investigations	170,000		
Missile engineering		590,000	590,000
Vehicle design studies	388,000		
Structures	28,000		
Application of superconductors	111,000		
General studies	63,000		
Solid propellent research and development		1,230,000	1,230,000
Propellent development	458,000		
Propellent engineering	772,000		
Liquid propellent research and development		1,450,000	1,450,000
Propulsion system development:			
45,000-pound-thrust N_2O_4/N_2H_4 system	615,000		
20,000-pound-thrust engine	155,000		
Propulsion system analysis	62,000		
General supporting studies:			
Development of propellants and auxiliaries	315,000		
Combustion and injection research	303,000		
Advanced propulsion systems		314,000	314,000
Materials research		840,000	840,000
Solid state research	160,000		
Metallurgy	245,000		
Ceramics	108,000		
Missile materials	172,000		
Graphite	155,000		
Basic studies in chemistry and physics		960,000	960,000
Applied chemistry	305,000		
Propulsion physics	655,000		
Instrument development		$680,000	$680,000
Instrumentation research	244,000		
Computer research	436,000		
Propellent and propulsion research		1,132,500	1,132,500
Heat transfer	355,000		
Rocket motor injector research	200,000		
High-performance storable liquids (chemical investigations)	21,000		
High-energy solid propellent research	200,000		
Atomization and injector hydraulics	53,500		
Combustion research	300,000		
Minor construction		60,000	60,000
Storage vault	18,000		
Addition to cafeteria building	34,500		
Miscellaneous	7,500		
Total		8,156,500	8,156,500

Mr. THOMAS. I note the request is in the amount of $8,156,500. I believe you stated a while ago there were 2,300 jobs out there.

CONTRACT WITH CALIFORNIA INSTITUTE OF TECHNOLOGY

At this point in the record will you please give us the highlights of your contract, the salary scale that is paid, and what the 2,300 people do at the Jet Propulsion Laboratory operated by the California Institute of Technology at Pasadena, Calif.

(The information requested follows:)

NASA has a negotiated cost reimbursement contract (NASW-6) with the California Institute of Technology for the operation of the Jet Propulsion Laboratory and the performance of certain research and development projects. The initial NASA funding of $8,156,500 covers operations for the calendar year 1959. The scope of the contract includes basic and applied engineering research and operation as directed by NASA in the fields of propellants, guidance and control, communication, aerodynamics, materials, structures, chemistry, physics, heat transfer and cooling, fluid mechanics, instrumentation, combustion, and vehicle development and testing. Other specific research and development projects are assigned to JPL under contract NASW-6 as required by NASA. To date, a total of $8,850,000 in fiscal year 1959 funds has been committed for such projects, and is chargeable to specific programs (e.g., deep space probes and the

Vega vehicle development in the R. & D. appropriation). A negotiated amount of $1 million per annum is provided by the contract for California Technology overhead and management, to be applicable so long as the direct wage and salary expenditures at JPL are within the range of $19 to $24 million annually. This allowance is shared by NASA, Army Ordnance, and Air Force in proportion to each agency's use of JPL personnel. At present, and for the next fiscal year, at least half of JPL's total work will be for the Army and the Air Force.

The staff of the JPL consists of approximately 600 professional personnel, 700 technicians and technical support personnel, and 1,047 service, shop, maintenance, and administrative personnel. Their distribution by salary ranges is as follows:

Annual rate:	*Total employees*
0 to $5,999	1,197
$6,000 to $7,999	618
$8,000 to $10,999	338
$11,000 to $14,999	150
$15,000 to $17,999	33
$18,000 and up	11
Total	2,347

A distribution of the staff by areas of work in which they are engaged is as follows:

Area of work:	*Employees*
Supporting research for NASA under contract NASW-6	510
Other specific projects for NASA under contract NASW-6	458
Research on Sergeant program for Army	822
Wind tunnel research for Army and Air Force	281
Other research for Army	276
Total	2,347

In carrying out this work, the Jet Propulsion Laboratory maintains the facilities and retains the personnel necessary to fabricate and develop items for feasibility and prototype demonstrations. However, JPL does not have production facilities and depends on industrial support to provide even limited quantities of a new item.

CONSTRUCTION

Mr. THOMAS. I note that there is another item over here of about $9 million for construction out there.

Mr. ULMER. Yes, sir.

Mr. THOMAS. So, that makes a total of about $17 million in 1 year. You state in your justifications as follows:

The Jet Propulsion Laboratory, operated by the California Institute of Technology at Pasadena, Calif., under control and funding by the Department of the Army, has been carrying on research in many areas associated with the development of missiles and space vehicles.

Some of this work had specific military application; a large portion of the work was more general in nature. The technical knowledge resulting from the work is applied to the design, propulsion, operation, and guidance of improved missiles.

For what do you plan to spend this $8 million this year?

Dr. SILVERSTEIN. The program is outlined, Mr. Chairman, on page 227. You will note that the items include work in research and development on guidance and control of space vehicles. Here we are talking about being able to get our space vehicles to come closer to the moon or to the planets. Extreme range communications is listed as one of the items. The farther out we go the better the type of communications we need.

You will also note that there is work on missile engineering. We are talking about the design of these very complicated missile structures.

POSSIBILITY OF ABSORBING ACTIVITY IN OTHER INSTALLATIONS

Mr. THOMAS. Could not this activity very well be absorbed at your four other installations?

Dr. SILVERSTEIN. It could be if you increased the personnel in the same way. This laboratory, of course, is a going concern, and it has been a going concern for many years.

Mr. THOMAS. Well, your laboratories are going concerns and have been for many years, and you have spent a lot of money on them. You have had a total of about 8,800 people in all three of them; have you not?

Dr. SILVERSTEIN. These people, I think, should be recognized as being pioneers in the space business. We have taken on these new obligations which you are well aware of and which are needed, I think, in carrying on this vigorous program which Congress and all Americans want to be carried on.

Mr. THOMAS. Do they have a monopoly in this field?

Dr. SILVERSTEIN. No, sir; but they might be considered to be real pioneers in this field. They were the earliest workers in the solid-rocket business.

You will recall that I showed you the JUPITER vehicle that was put up. The entire upper part of this vehicle was fabricated at JPL and that was done very quickly because of the fact they had this background of research. They put the satellite together—the actual piece of hardware that goes on top of the missile.

We have to recognize the fact that there are not many places which have done this type of work, and these people are experts in this business. It was essential that we pick up at places such as this the existing talent to do the job, or we could not move along. We could attempt to build such facilities some place else, but this is not our understanding of the intent of Congress in setting up this legislation and not the intent of the people who wish to move ahead quickly.

We are using the people who have this talent and who have developed it over a number of years, and have not tried to create it somewhere else.

Otherwise, you increase the payroll of the U.S. Government. However, these people at JPL are in business so why create a new business?

Mr. THOMAS. Have you not been doing some of this work at your old laboratories?

Dr. SILVERSTEIN. Well, of course, our work was never aimed at the development of vehicles—never aimed at actually creating or building those that fly. The Air Force has always done this, and we have always backed up the Air Force by providing the basic research.

Mr. THOMAS. Suppose there is a little attention to saving a few dollars and getting the job done also? Could this work be absorbed at your three laboratories and carried on with any degree of efficiency?

Dr. SILVERSTEIN. To set up a good laboratory with a good and competent staff of scientific personnel would probably take 5 years.

Dr. GLENNAN. It would take longer than that.

Dr. SILVERSTEIN. This laboratory has been in operation for 15 years and it is backed up by the major universities on the west coast. These people are talented, and do a job as a team. Of course, you

could break the team up and locate it somewhere else, but you will not have the same team as exists at this installation and get the job done.

We are using this because it exists, and it is good, and everyone recognizes that fact.

Mr. THOMAS. When you said "break up the team," you mean the people would not want to leave their present location?

Dr. SILVERSTEIN. Not necessarily. Every man is a man unto himself, and he has his own problems. If you pull him out of his present location, he has to break his home up and, of course, there are other matters involved and you might get half of them to locate at another place. JPL is a going concern and it is a good team.

Mr. THOMAS. We listened to that same argument when we built some laboratories in Tennessee in the mountains and some laboratories in New Mexico in the mountains, and some in Washington in the mountains, and people went there.

Dr. SILVERSTEIN. Yes, sir; you can build a laboratory, and we have demonstrated in the past——

Mr. THOMAS. You have these three big installations already built.

Dr. GLENNAN. Mr. Chairman, those laboratories were built in the wartime under stress of wartime conditions when a lot of us did things we did not particularly like to do. Once those laboratories are established, they are not about to be changed, and shifted some place else.

If this law which says that one of our objectives is the preservation of the role of the United States as a leader in aeronautical and space science really means what it says—while I recognize the importance of the questions you are asking, it seems to me that this Agency has operated with just plain, commonsense in trying to acquire existing agencies which are deeply devoted to this, and which are staffed with excellent people—the best people in the country—and move ahead with the program——

Mr. THOMAS. You think it is best to leave it as it is, then?

Dr. GLENNAN. I do not see how you can do this otherwise, without a delay period of 5 to 10 years.

Dr. DRYDEN. If this responsibility were transferred to our laboratories, we would have to build new buildings and acquire types of equipment which we do not have and obtain a different kind of personnel, and pull it together, and it would take at least 5 years if you decided to do it that way.

OTHER LABORATORIES AVAILABLE

Mr. YATES. Suppose something happened to this Jet Propulsion Laboratory? Are there other laboratories such as this in the country?

Dr. GLENNAN. There are no other centers of this kind in the country. I think this is a reasonable statement.

Dr. SILVERSTEIN. If something should happen to it—let us be practical about it—certainly these people would have to move and try to develop a facility elsewhere, but it would take time.

Mr. YATES. I can see the need for this laboratory and a need for comparable laboratories in other parts of the country, but I wonder whether there is any movement to establish other laboratories in other parts of the country.

Dr. DRYDEN. There is some competence in various industrial laboratories, but it would be very difficult to use them in exactly the same way.

Mr. YATES. An institution like MIT would not be qualified to carry on this work?

Dr. DRYDEN. The Lincoln Laboratory at MIT is the same kind of laboratory operated under contract with the Air Force in the field of air defense. As a matter of fact, we also have some contracts with the Lincoln Laboratory.

Dr. GLENNAN. In those areas which impinge upon our interest, but that laboratory was built to serve some other purpose.

Mr. YATES. What you are saying is that Mr. Thomas was right in stating that this laboratory has a monopoly. It has a monopoly of excellence, according to your testimony.

Dr. GLENNAN. In this particular field at this particular time, that is right, sir.

Dr. SILVERSTEIN. They were the pioneers in the sense that when this field broke, because of the fact that they had been carrying on projects like Corporal and Sergeant and working with guidance systems and working with solid rockets, they were in a position to capitalize on their background and to move rapidly, and in 4 months after sputnik was put up this program was set up to put a Jupiter—a top stage on it—and we fired a vehicle.

PROBABLE FUTURE NEED FOR DEVELOPMENT OF OTHER LABORATORIES

Mr. THOMAS. If this is so important, you had better build some other installations, because you will need them.

Dr. SILVERSTEIN. I think you are right. I think this field is going to get big enough so that we will need them.

Mr. THOMAS. You had better start looking around.

Dr. GLENNAN. I think we need to look at our growing program.

Mr. THOMAS. You have some health hazards. You want to spend in physical properties $9 or $10 million more. So you had better put your money some place else.

Dr. GLENNAN. I think we need, really, to take a longer look than the 8 months we have been in business at all the long-range objectives under the normal process of government.

What do you want this to grow to? Do you want an atomic energy business at a cost of $3 or $4 billion a year? There are certainly additional things we ought to do, but it will take more time to develop a fully balanced approach to a new field which has been admittedly under a substantial amount of pressure from scratch. Moreover, in this instance, we started in the public eye, as against the Atomic Energy Commission which was completely under wraps and few knew what it was all about when it started. But certainly within another year the needs for growth in this space area are going to be very much more apparent to us. I would think that another year of budget experience might reflect the additional efforts you are talking about.

Mr. YATES. I think Mr. Thomas had a point in expressing his concern that by concentrating and building permanent installations in one location, you are preventing an expansion of this activity.

Dr. GLENNAN. Would you, then, Mr. Yates, have us not work with them?

Mr. YATES. Oh, no. I would not have you not work with your existing facilities because you have a job to do and these are all the facilities with which you have to work.

Dr. GLENNAN. Yes, sir. What we are looking forward to today, indeed, includes the development of other laboratories but for the workload that we see at the present time, we think we can do it for the coming year as we have planned it, the bulk of it being managed contracts within the industry and with other portions of the armed services and ABMA where we are trying to make use of the great talent that is down there in the rocket propulsion field.

Surely, Dr. Silverstein would agree, it is possible that if we move forward with developments and find promising fields, there will be offshoots which would give rise—solid, sensible rise—to the development of new centers very much as in the Atomic Energy Commission when we had Los Alamos. I happened to be there when we had that great debate as to whether or not we should have a second laborary and it took us 2 or 3 years before we found the people, located the place where we wanted to do this work, and then moved ahead.

Mr. THOMAS. That is right.

Mr. YATES. We do not have very many in this field if they are all in one laboratory.

Dr. GLENNAN. Space is a new field, sir. There are people that are developing competence at places like STL and places like RCA and some of the universities. The State University of Iowa where Mr. Van Allen comes from is one instance, and there are people at some of the aircraft plants, that, of course, are developing an increasing interest in the field.

NATURE OF CONTRACT WITH JPL

Mr. YATES. What is the nature of the contract that you have with the laboratory? Does this provide a profit for the laboratory?

Dr. GLENNAN. No, sir; this is a nonprofit institution. We will be glad to supply that contract to you.

Mr. YATES. I do not think that is necessary, but I wanted to find out whether it was a profit contract for the institution.

Dr. GLENNAN. No, sir.

Mr. YATES. This is cost-plus essentially?

Dr. GLENNAN. We pay their costs and overhead management allowances.

Mr. SIEPERT. The arrangement is a continuation of the same kind of financial procedure as Army Ordnance had, which has been the manager of this contract since the laboratory was started. An arrangement is made with the California Institute of Technology each year in which we agree upon a fixed amount in lieu of the indirect overhead costs to the institute of managing this operation.

This is a fixed management allowance, working it out each year, and the allowance is based upon the gross amount of personal services or wages that would be paid within the Jet Propulsion Laboratory as compared with all other Caltech salaries so that we pay a proportionate share of Caltech's total overhead for the management of the JPL situation.

You see, the Caltech costs have to be distributed between their academic programs, our contract, and other Government contracts that are being handled by them. There are some 50 other contracts.

Mr. RHODES. Mr. Chairman, are we going to get a list of these contracts which make up the $300 million? They are not in the justifications, and it seems to me that somewhere in the record we ought to have a list of them.

Mr. ULMER. Mr. Rhodes, we do not have a list of the contracts that make up the $333 million because those, of course, have not yet been negotiated; we do have a list of all contracts we have let to date against our current research and development appropriation. We can make that list available to you if you wish.

Mr. THOMAS. When we get into the contracts, then we will go into the details of it.

PROPELLANT DEVELOPMENT AND ENGINEERING

I have a question mark here on page 228 where you have propellant development in the amount of $458,000, and propellant engineering in the amount of $772,000. Is not that a duplication of the work going on at Cleveland? This is the support of your JPL laboratory. Is not that a duplication, Dr. Silverstein? Is not this right up your alley?

Dr. SILVERSTEIN. Yes, sir; very much so.

Mr. THOMAS. You do not admit that those people out there are better than your group; do you?

Dr. SILVERSTEIN. This is is not a duplication.

Mr. THOMAS. Do they have a monopoly on this and you have to go out there and listen to them?

Dr. SILVERSTEIN. The point, sir, is this——

Mr. THOMAS. I thought you were the professor in the field.

Dr. SILVERSTEIN. The NACA always took the position that we did not need to duplicate the work going on at other centers, and we never did get into solid propellants because it was being handled by others.

Mr. THOMAS. I thought you were going into all types of fields out there. You have a fine big laboratory and you even talked Dr. Glennan into giving you an atomic installation.

Off the record.

(Discussion off the record.)

Dr. SILVERSTEIN. We have not put much emphasis on these solid propellants because we recognize the fact that it was going on at places like JPL. As I recall, at the time I left the total number of people we had in the solid propellant area was two men basically looking at the higher energy chemical solids. This was our total effort. This is not a duplication. If it were, I would not propose doing it, but it certainly is not.

Mr. THOMAS. Let us take a look at your project on page 230 of the justifications.

RESEARCH CONTRACTS

We shall insert at this point in the record pages 230 and 231 of the justifications.

(The pages referred to follow:)

RESEARCH CONTRACTS

Fiscal year 1959	$4,000,000
Fiscal year 1960	5,200,000

1. Objectives

To draw upon universities and other research establishments for fundamental and applied research necessary for advancing aeronautical and space technology.

2. Justification

In order to provide scientific knowledge for existing programs in aeronautical and space technology and to build a foundation for future programs, there is an urgent and continuing need for NASA to augment its present capabilities by utilizing the research potential of the universities and research institutes of the Nation. Not only must existing research groups be utilized but additional ones must be created to accelerate the advance of space sciences to the maximum extent. Important problem areas may be grouped as follows:

(1) The physical sciences encompass the fundamental research problems related to structural and special purpose materials, propulsion methods, instrumentation, theory of information handling and analysis, and others. To permit advances in applied science, increased understanding is needed in many areas of fundamental physical science.

(2) The cosmological sciences include planetary sciences, astrophysics and astronomy, which are concerned with characterizing material particles and bodies in space, radiation, their variations and evolutons, and the expermental techniques of acquiring this knowledge. Practical questions such as tracking and guidance, environmental hazards of space flight, and the possible utilization of energy and matter in space all require substantially increased knowledge and techniques which must come from fundamental research.

(3) The life sciences include the fundamental study of physiology and biophysics to ascertain the limitations and hazards of manned space flight, owing to radiation, acceleration, weightlessness, and to other problems. Biochemistry related to sustenance of life, and behavioral adaptation in the space environment are also important basic research areas.

(4) The engineering sciences encompass important areas of fundamental engineering research, such as energy production and conversion processes, solid state or molecular transition electronic devices, guidance principles and techniques, trajectory problems, hypervelocity fluid dynamics, and plasma production, as examples. The calculation of optimum design and probabilities of mission performance, through system analysis techniques, requires research to increase the capability of this engineering science to permit treatment of the complex space systems.

(5) The NASA research associateship program, to be administered jointly by the National Academy of Sciences and the National Research Council, will provide to investigators of unusual ability and promise an opportunity for basic research in the various areas of science having to do with space exploration, including upper atmosphere physics, astrophysics, and plasma physics.

3. Program costs

	Fiscal year 1959	Fiscal year 1960
Physical sciences	$1,150,000	$1,100,000
Cosmological sciences	800,000	900,000
Life sciences	450,000	1,250,000
Engineering sciences	1,250,000	1,600,000
NASA research associateships	350,000	350,000
Total	[1] 4,000,000	5,200,000

[1] Includes $1,000,000 funded under the "Salaries and expenses" appropriation title.

Mr. THOMAS. What is the difference between these and the others? You spent $4 million last year and you want to go to $5.2 million in 1960.

Your justifications state as follows:

To draw upon universities and other research establishments for fundamental and applied research necessary for advancing aeronautical and space technology.

Dr. DRYDEN. Extended to the space area as well as to the old area.

Mr. THOMAS. Reading further:

The physical sciences encompass the fundamental research problems related to structural and special-purpose materials, propulsion methods, instrumentation, theory of information handling and analysis, and others. To permit advances in applied science, increased understanding is needed in many areas of fundamental physical science.

Is there anything new in that?

Your justifications further state:

The cosmological sciences include planetary sciences, astrophysics, and astronomy which are concerned with characterizing material particles and bodies in space, radiation, and their variations, and evolutions, and the experimental techniques of acquiring this knowledge.

Practical questions such as tracking and guidance, environmental hazards of space flight—

and so forth.

Then, you have the life sciences and you state the following:

The life sciences include the fundamental study of physiology and biophysics to ascertain the limitations and hazards of manned space flight, owing to radiation, acceleration, weightlessness, and to other problems. Biochemistry related to sustenance of life, and behavioral adaptation in the space environment are also important basic research areas.

Then, you have the engineering sciences and next is the NASA research associateship program. What is that? You state that it is to be administered jointly by the National Academy of Sciences and the National Research Council and will provide to investigators of unusual ability and promise an opportunity for basic research in the various areas of science having to do with space exploration, including upper atmosphere physics, astrophysics, and plasma physics.

Off the record.

(Discussion off the record.)

Mr. THOMAS. What about the Research Council?

Dr. DRYDEN. This is the same thing——

Mr. THOMAS. But, we are making two appropriations.

Dr. DRYDEN. This wording "the National Academy of Sciences and the National Research Council," I have not noticed before. They are essentially the same organization. It is usually written with a hyphen.

Mr. THOMAS. But it is a committee within a committee, and a good many agencies make appropriations to each.

Dr. DRYDEN. The Academy of Sciences are the only people who have any power to make any contracts. The Research Council is the operating organization which they set up to carry out their functions.

Mr. THOMAS. Of course, the National Academy of Sciences has some statutory standing.

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. It is not a Government agency, but it was created by the Government.

The Bureau of Standards makes a contribution to it.

What do you expect to get out of this?

Dr. DRYDEN. We expect to get some bright young people who would not otherwise come to work with us on a permanent basis.

Mr. THOMAS. You had appropriated to NACA last year for research contracts for your installations how much money?

Mr. ULMER. $1 million, Mr. Thomas.

Mr. THOMAS. And you have advanced that from $1 million to $4 million for 1959?

Mr. YATES. And $5 million for 1960.

Mr. ULMER. Yes, sir.

Mr. THOMAS. With whom did you do business in 1959 and with whom do you expect to do business in 1960?

Mr. ABBOTT. Sir, I have a list of the projects which have been approved as of April 20. There are 50-some projects.

Mr. THOMAS. Will you please insert that into the record at this point?

Mr. ABBOTT. Yes, sir.

(The list referred to follows:)

Summary of projects approved for grant or contract by Office of Research Grants and Contracts, Apr. 20, 1959

Institution	Number	Amount	Institution	Number	Amount
Armour Research Foundation	2	$90,000	University of Michigan	8	$474,570
Polytechnic Institute of Brooklyn	1	15,100	University of Minnesota	1	30,514
University of California	2	134,800	National Bureau of Standards	4	111,317
California Institute of Technology	3	163,860	New York University	3	183,931
Catholic University	1	27,500	Northwestern University	1	1,676
University of Colorado	1	41,000	Ohio State University	1	28,889
Denver University	1	49,815	Pennsylvania State University	1	15,450
Electro-Metallurgical Corp	1	25,440	Rennsalaer Polytechnic Institute	1	84,384
University of Florida	1	64,320	Rice Institute	2	605,550
Franklin Institute	1	15,000	Stanford University	3	79,134
University of Illinois	1	23,057	Stanford Research Institute	1	45,041
Iowa State University	1	2,900	University of Virginia	1	34,200
John Hopkins University	1	13,252	University of Washington	1	4,640
Marlin-Rockwell Corp	1	39,521	Yale University	3	245,710
University of Maryland	1	59,424	Total	50	2,709,999

Mr. THOMAS. By whom will they be investigated?

Mr. ABBOTT. Would you like to have some of these read?

Mr. THOMAS. Yes.

Mr. ABBOTT. First is the Armour Research Foundation, Polytechnic Institute of Brooklyn, University of California, with two contracts; the California Institute of Technology, three; Catholic University, one; the University of Colorado, one; Denver University, one; Electro-Metallurgical Corp., one.

The University of Florida—most of these were one contract—one; Franklin Institute, one; and so on down the line.

Mr. THOMAS. Is that your 1959 list or your 1960 list?

Mr. ABBOTT. This is a list so far for the fiscal year 1959.

Mr. THOMAS. Are these 1-year contracts?

Mr. ABBOTT. They vary from 1-year to 3-year contracts. Under the old NACA they were all 1-year contracts. There has now been an extension of our authority. We feel it is better to enter into longer range contracts when the circumstances warrant it. A great many of these are 3-year contracts.

Mr. THOMAS. Well, are you not running a little fast here, Dr. Dryden?

Dr. DRYDEN. No, sir; I do not think so. As you indicated, there are several new areas, for example the cosmological sciences, which is a completely new field.

Dr. GLENNAN. And the life sciences.

Mr. THOMAS. What about your sounding rockets?

What is the amount, Dr. Abbott, of some of the average contracts? What do they average dollarwise each?

Mr. ABBOTT. Approximately $50,000 on the average.

Mr. THOMAS. You have life sciences listed at $450,000, engineering sciences, $1,250,000, physical sciences, $1 million, and so forth.

What is the routine through which you go to make these contracts, who makes them and screens them, and who evaluates the net results of your investigations, and so forth?

These are all contracts for pure research?

Mr. ABBOTT. Yes, sir; these are contracts for basic research.

Mr. THOMAS. There is no prototype development in here, is there?

Mr. ABBOTT. No, sir; it is basic research rather than applied.

The usual process is that we get a great many unsolicited proposals, although we do go out and solicit proposals in certain fields where we want to encourage particular types of work.

Mr. THOMAS. Do you have a staff in the central office which works on this? If so, how many people do you have? Or do you have a staff at each one of your installations and your research plants?

Mr. ABBOTT. We have a central staff that works on this but not in the sense that they do the complete evaluation. They handle the contacts with the universities so everything is channeled through them. They will contact the people who are quite familiar with the basic research problems.

Mr. THOMAS. Please give us some details as to how many people you have engaged in this activity and where they are located.

Mr. ULMER. We have eight people in this work at headquarters.

Mr. THOMAS. Do you have any at your laboratories?

Mr. ULMER. No, sir; this is done entirely at headquarters.

Mr. ABBOTT. We do not have any at our installations as a group.

Mr. THOMAS. These people make the contracts and evalute what is being done?

Mr. ULMER. That is correct. They handle the technical evaluation of the contracts.

Dr. DRYDEN. And the technical administration of the contracts. Many of these contracts are sent to the laboratories and their reports come back into the central office.

Mr. ABBOTT. Each one is referred to a specialist within our organization, wherever one may be in that particular field, and if there is more than one group of specialists, they are referred to each group of specialists so that we get the full input on the evaluation both of the proposals, the cost of the work, and the opinions from experts within our organization.

This central group is a group that sees to it that this activity takes place.

Dr. DRYDEN. The important point is that we do not use outside advisory committees in this activity.

Mr. THOMAS. You do your own evaluations and let your own contracts, and everything?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. What is your personnel load that works on these and does your evaluation?

Do you have a separate unit set up just for this?

Dr. DRYDEN. No, sir. No one gets more than three or four of these proposals a year, so the evaluation is done in addition to a man's ordinary duties.

Mr. THOMAS. In other words, this is home reading?

Mr. SIEPERT. The total personnel devoted primarily to this task are limited to the eight people that Mr. Ulmer mentioned which are currently on the job and it is proposed that 11 would be the total in 1960.

The only other is one procurement or contract man and one-half of a clerk's time who actually writes up the contract instruments.

Mr. THOMAS. Will you insert the titles of those jobs and the salaries in the record at this point and also the staff doing this under the old act. Most of these contracts are with universities?

(The information follows:)

Office of Research Contracts and Grants

	Per annum salary
Authorized number of employees, May 29, 1959:	
Chief, university contract program	$17,000
Assistant Chief, university contract program	16,500
Scientist for space medical research	19,000
Space and aeronautical scientist	15,500
Aeronautical research scientist	13,970
Aeronautical science editor	7,030
Editorial clerk	5,130
Secretary	5,090
Contract records clerk	4,940
Clerk-typist	4,325
Secretary	4,190
Secretary	4,040
Total (12 employees)	116,715
Authorized number of employees, Oct. 1, 1958:	
Chief, university contract program	15,150
Aeronautical research scientist	13,970
Aeronautical science editor	7,030
Editorial clerk	5,130
Secretary	4,790
Secretary	4,640
Clerk	4,640
Total (7 employees)	55,350

Mr. SIEPERT. Yes, sir.

Mr. THOMAS. You have to buy some equipment for them to work on. Do you furnish the money and they buy the equipment?

Mr. THOMAS. Within the limitation of funds, do some of them say give me $10,000 and you furnish this equipment?

Dr. DRYDEN. They furnish a cost breakdown as to how they propose to spend the money, and we go over that before we approve the contract.

Mr. YATES. You screen your contracts for basic research with the National Science Foundation?

Dr. DRYDEN. The eight people in this office exchange information with the Science Foundation, the Office of Air Research, and the Office of Ordnance Research so that proposals that come in do not get played off one against the other so to speak. We know what the others are doing.

We actually get notices of proposals submitted and acceptance. So it is not a joint screening, but there is an exchange of information on what each is considering. If we find that a particular proposal has been before the Science Foundation for their evaluation, we would obtain it.

Mr. YATES. Thank you.

SCIENTIFIC INVESTIGATIONS IN SPACE

SOUNDING ROCKETS

Mr. THOMAS. At this point in the record we will insert pages 232, 233, and 234 of the justifications having to do with scientific investigations in space.

(The pages referred to follow:)

SOUNDING ROCKETS

Fiscal year 1959	$5,000,000
Fiscal year 1960	10,000,000

1. Objectives

To measure and understand the nature, extent, electrification, and dynamical behavior of the earth's atmosphere. To investigate the interactions of incident electromagnetic and particle radiations with the earth's atmosphere. To determine the relation between phenomena in the high atmosphere and surface meteorology. To conduct exploratory geophysical and astrophysical investigations leading to later satellite and deep space probe experiments.

2. Justification

A sounding rocket is defined as a rocket that can carry a usable scientific payload out to a distance up to one earth's radius from the surface of the earth. Such a vehicle affords a means of studying the earth's atmosphere in vertical cross section out to a distance at which it merges with the medium of interplanetary space. In support of the above objectives, many investigations of atmospheric structure, composition, ionization, motions, aurora, airglow, absorption of solar radiation, and interactions with cosmic rays and other particles can best be conducted by means of sounding rockets. The current NASA program continues the rocket sounding of the past 12 years, and is based on the experience obtained from the earlier work.

The current NASA sounding rocket program has three phases: (*a*) Investigations up to the E-region of the ionosphere at roughly 100 kilometers; (*b*) investigations in the region between 100 kilometers and the maximum of the F-region of the ionosphere at between 300 and 400 kilometers; and (*c*) investigations from 400 kilometers out to 6,000 kilometers. From the rocket sounding activity of the past 12 years a fairly complete picture of the atmosphere up to about 100 kilometers has begun to emerge. Phase (*a*) of the program is directed toward filling in the remaining gaps, and includes detailed measurements of geographic and temporal variations of atmospheric characteristics and high-altitude phenomena, using smaller sounding rockets like the Arcon. Between 100 and 400 kilometers a considerable amount of data have been accumulated, but only enough to delineate the bare outlines of the whole picture. Phase (*b*) of the NASA program is directed at investigations of this portion of the atmosphere, using moderate altitude rockets like the Aerobee-Hi, Iris, and Spaerobee. Above the 400 kilometer level, rocket sounding is only in its beginning stages. Phase (*c*) will pick up this part of the work, using high-performance rockets and rocket combinations that will be adapted especially for the task.

3. Program phasing

The 1959 funds will permit the procurement of approximately 50 sounding rocket boosters. Funds are also included for the development of improved sounding rockets, and for payload development, and fabrication. The payloads will be developed partly at the NASA Space Projects Center and partly under contract. The 1960 funds will provide some 100 rocket boosters and payloads.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Studies on measurement techniques	$200,000	$300,000
Sounding rocket systems studies	100,000	200,000
Prototypes and operational hardware:		
Rocket vehicles	1,000,000	2,000,000
Payloads	1,000,000	2,000,000
Developmental sounding rockets	1,000,000	2,000,000
Operations and technical services:		
Launching of rockets	400,000	900,000
Data acquisition, reduction and analysis	300,000	600,000
Supplies, equipment, repairs, and alterations: Test equipment, mobile launching units, recording materials, minor modifications to existing facilities	1,000,000	2,000,000
Total	5,000,000	10,000,000

Mr. THOMAS. Now, this is getting into one of your new activities; is it not?

Dr. DRYDEN. This is the one that Homer Newell presented yesterday.

Mr. THOMAS. You state in your justifications as follows:

To measure and understand the nature, extent, electrification, and dynamical behavior of the earth's atmosphere. To investigate the interactions of incident electromagnetic and particle radiations with the earth's atmosphere. To determine the relation between the phenomenon in the high atmosphere and surface meteorology. To conduct exploratory geophysical and astrophysical investigations leading to later satellite and deep space probe experiments.

A sounding rocket is defined as a rocket that can carry a usable scientific payload out to a distance up to one earth's radius from the surface of the earth.

Gentlemen, I have that underlined, and I say "How many miles is one earth's radius?"

Dr. DRYDEN. It is 4,000 miles, and it should read more accurately "out to as deep a distance," as Dr. Newell described. Some go only up to 20 miles or 50 miles; 4,000 miles is the point at which we change the name. If it goes beyond 4,000 miles we call it a space probe.

Mr. THOMAS. You further state:

In support of the above objectives, many investigations of atmospheric structure, composition, ionization, motions, aurora, airglow, absorption of solar radiation, and interactions with cosmic rays and other particles can best be conducted by means of sounding rockets. The current NASA program continues the rocket sounding of the past 12 years, and is based on the experience obtained from the earlier work.

I have 12 years underlined.

Dr. DRYDEN. This is the 12 years of the developments that started at the time we captured the V–2 rockets.

Mr. THOMAS. As a matter of fact, you have been shooting our rockets at Wallops Island for the past 8 years?

Dr. DRYDEN. Not for the purpose of sounding the atmosphere.

Mr. THOMAS. For what?

Dr. DRYDEN. For research of airplanes, missiles, and problems connected with them.

Mr. THOMAS. You have been shooting them just the same.

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. So, it is not a novel experience with you, then; is it?

Dr. DRYDEN. No, sir.

Mr. THOMAS. As a matter of fact, you received a little money 2 or 3 years ago, complaining that the Air Force had shut you off.

Dr. DRYDEN. One of the services had been charging us for the rockets.

Mr. THOMAS. They cut off your credit.

Dr. DRYDEN. They cut off the free contribution.

Mr. THOMAS. You further state that this is going to be the basis of your expanded activities in the future. If you get the information, it is worthy of further investigation.

How will you spend this $10 million?

Dr. DRYDEN. There is a breakdown here of the vehicles.

Mr. THOMAS. You state that you will investigate up to the E region of the ionosphere, roughly 100 kilometers. How much is a kilometer?

Dr. DRYDEN. Six-tenths of a mile.

Mr. THOMAS. Everything in Europe is measured in kilometers; is it not?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. You further state:

> Investigations up to the E region of the ionosphere at roughly 100 kilometers; investigations in the region between 100 kilometers and the maximum of the F region of the ionosphere between 300 and 400 kilometers, and investigations from 400 kilometers out to 6,000 kilometers.

Reading further, there is this language:

> The NASA program is directed at investigations of this portion of the atmosphere—

Well, summarizing it, what does it mean?

Dr. DRYDEN. I do not think I can do it any better than Homer Newell did where he gave you the specific program yesterday. There are certain sounding rockets——

Mr. THOMAS. Incidentally, and for the record, we have seen Dr. Newell in here 3 or 4 years, and if he is not a topper, I have never seen one. He has it, has he not?

What is his age?

Dr. GLENNAN. About 43, I believe.

Mr. THOMAS. Did you get him from the Naval Research Laboratory?

Dr. DRYDEN. Yes. We asked the opinion of the leading authorities around the country as to who was the best man for this program, and two names came up.

Mr. THOMAS. Is he not in one of the excepted classifications?

Dr. DRYDEN. Yes, sir; he is the Assistant Director for Space Sciences.

Mr. THOMAS. I do not want to brag on you too much because we do not want to ruin you, but, so far, you are doing all right.

Dr. DRYDEN. He is the leader in that field.

Another leading man is Dr. Van Allen, whose face is on the cover of Time. We did discuss with him whether he would come with us, also.

Mr. THOMAS. You are talking about all of our old customers, Doctor.

Dr. DRYDEN. They are the best in the business.

Dr. GLENNAN. And they have done things.

Mr. THOMAS. May I call the committee's attention to this table on the bottom of page 233 with specific reference to the 1959 funds? This is $10 million. It jumps up from $5 million to $10 million for 1959 and 1960.

The justifications state as follows:

> Funds also included for the development of improved sounding rockets and for payload developments and fabrication. The payload will be developed partly at the NASA Space Projects Center and partly under contract. The 1960 funds will provide some 100 rocket boosters and payloads.

For "Studies on measurement techniques" in 1959 you had $200,000; for "Sounding rocket system studies" you had $100,000; for "Rocket vehicles" you had $1 million as against $2 million requested for fiscal 1960, and for "Developmental sounding rockets" you had in 1959 $1 million and in 1960 you are requesting $2 million.

Mr. THOMAS. How did you arrive at such figures? How much guesswork is involved here? Would that be 50 percent?

Dr. SILVERSTEIN. There is a background of about 12 years, as was mentioned here, in doing this kind of work, and the cost of these things have been determined.

Mr. THOMAS. Who figures the cost for you? Who does this work?

Dr. SILVERSTEIN. Dr. John Townsend, who was with NRL. He was Dr. Newell's assistant. He has fired these rockets for years and he knows what the cost is, and what it costs to fire them.

These estimates are very good estimates, and are based upon many years' background.

Mr. THOMAS. Does he do the procuring and everything?

Dr. SILVERSTEIN. The procurement would, of course, be done under our contract offices, but he will write up the specifications for the procurement.

Mr. THOMAS. That is two separate and distinct things. One is a separate business quite distinct from the other?

Dr. SILVERSTEIN. Yes, sir; but these people are qualified. We have pulled together one of the best teams in the country in this area.

Mr. THOMAS. We do not have the slightest quibble about that. If they are with Dr. Newell, they are all right.

Why this cost? How did you arrive at it? You have round figures in here.

Dr. SILVERSTEIN. For example, in our program we have set up a program of payloads that requires some 100 rockets during calendar year 1960. These use existing rockets in 75 to 80 percent of the cases, as, for instance, the AEROBEE rockets. We have the cost of these things and they are contract items and we can actually determine a budget like this accurately.

Mr. THOMAS. You had $5 million for this purpose last year. How many rockets were shot in the first 7 months of this year, and what did they cost you?

Dr. SILVERSTEIN. I think the cost for the rockets themselves is within the framework of this $1 million.

Mr. THOMAS. Break it down on the basis of your past experience for the first 6 months of 1959.

How many have you fired?

Dr. SILVERSTEIN. I would have to supply that for the record. I do not know today how many.

Mr. THOMAS. That is very important.

Dr. SILVERSTEIN. I think the number for calendar year 1959 will be around 30.

Mr. THOMAS. What was the cost of the 30? That is not your full $5 million?

Dr. SILVERSTEIN. I would have to go into our contract records to get that information.

Dr. GLENNAN. You will note the 1959 funds permit the procurement of approximately 50 of these sounding rockets and next year the funds are doubled, which provides for the cost of 100.

Dr. DRYDEN. I have some of the cost data.

Mr. THOMAS. First let us agree on some facts.

You had 50 for fiscal year 1959 and you want about 100 this year?

How many have you sent up in the first 5 or 6 or 7 months of 1959?

Dr. DRYDEN. I cannot give you the firings but I see here 42 vehicles ordered including 5 AEROBEES, 10 NIKE-ASP, 15 AEROBEE-HI, 7 SPAEROBEES, and others. The costs vary from $100,000 for 5 AEROBEES to $130,000 for 10 NIKE-ASPS, and $50,000 for the 7 SPAEROBEES, and $280,000 for 5 JAVELIN rockets.

That adds up to about $1.1 million.

Mr. THOMAS. In round figures it is $1 million. That is just the rockets themselves?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. Is this contract work or is this going to be done by your own personnel at Wallops?

Dr. ABBOTT. These are purchased rockets under contract.

Mr. THOMAS. But your entire $10 million covers the purchase of your rockets?

Dr. ABBOTT. That was in 1959.

Mr. THOMAS. What do you mean by payloads?

Dr. SILVERSTEIN. Payloads are the instruments that go on top.

Mr. THOMAS. What about developing sounding rockets?

Dr. SILVERSTEIN. The developing of sounding rockets involves three new ones, one called the ARCON, another IRIS, and AEROBEE-HI.

Mr. THOMAS. Your $5 million for 1959 is all for equipment and there is no payload in it?

Dr. SILVERSTEIN. No salaries and expenses in it. It is all for the development items.

Mr. THOMAS. And it will be expended, of course, at your installation at Wallops?

Dr. SILVERSTEIN. These will be fired from four different places.

Mr. THOMAS. Where are the other three places?

Dr. SILVERSTEIN. Fort Churchill in Canada, the proving grounds in New Mexico at White Sands, and the fourth place will be in the Pacific area. There will also be some fired in Australia in 1960.

Mr. THOMAS. You have not gotten that one yet? Do you have the money to set that one up?

Mr. WYATT. This kind of experiment requires very little in the way of ground equipment.

Mr. THOMAS. There are no salaries and expenses involved here?

Mr. WYATT. No, sir.

Mr. YATES. Why do you want to fire rockets in Australia?

Mr. WYATT. Because you can get into the southern atmosphere. We are interested in comparing the southern atmosphere with the northern latitudes.

Dr. DRYDEN. That will be a part of the cooperation internationally with the Australians. They will also contribute to this.

Mr. THOMAS. Off the record.

(Discussion off the record.)

Mr. THOMAS. What would you say there is in the way of salaries and expenses, travel and whatever we have going with the other 12 or 13 objects, that would complement this $5 million here in material?

Dr. SILVERSTEIN. During the current year there is a staff of some 90 men in Dr. Townsend's group who are responsible for this phase of the work and my estimate for those people would——

Mr. THOMAS. What do you mean by "staff of 90?" How many more are there besides the staff? You have to have a lot of good mechanics around there, and you have to have a lot of people who can carry a lot of wood and water.

Dr. SILVERSTEIN. This is the total of Dr. Townsend's group. They will work with our people at Wallops where we have a quota of around 97 people, and that group of course works on many things.

When this rocket program comes to Wallops, there is a group of mechanics who do the work on the project.

Mr. THOMAS. Would you say the salaries and expenses item would exceed the cost of the material in this fiscal year?

Dr. SILVERSTEIN. Not in any fiscal year.

Mr. WYATT. On a good many of these rockets they also contract with New Mexico A. & M. College which is an institution located close to White Sands. New Mexico A. & M. has handled a good amount of the field activities by contract.

Mr. THOMAS. Do you mean just salaries and expenses and not for equipment?

Mr. WYATT. No; we furnish the articles and they operate the tests. It is a service contract.

Mr. THOMAS. You say "developmental sounding rockets," in the amount of $2 million. What do you mean by that?

Dr. DRYDEN. This will be a contract with some group to develop a new small rocket. In fact, we say there are three of them.

Mr. THOMAS. What do you mean by a sounding rocket?

Mr. WYATT. It is defined as a rocket which goes vertically up to as much as 4,000 miles, or it may go only 50 miles.

Dr. DRYDEN. Sounding the depth of the ocean and sounding the atmosphere.

Mr. THOMAS. That is going down. You are getting in Dr. Revell's territory.

Dr. DRYDEN. No, sir; we will go up, but we took over one of his words.

Mr. SIEPERT. It is a sampling of the characteristics of the atmosphere at whatever height the rocket goes.

Mr. THOMAS. How did you arrive at those figures? This is not a stock item. You cannot buy it out of Sears, Roebuck's catalog?

Dr. SILVERSTEIN. We have proposals in this area of $2 million in 1959. In fact, we have proposals from about four different groups who are interested in developing this rocket to our specifications.

Mr. THOMAS. What companies would be interested in this?

Dr. SILVERSTEIN. One of the groups is at the University of Michigan. They are now working with Curtiss-Wright. There is another group associated with Aerojet Corp.

Mr. THOMAS. You mean that these are all airplane companies?

Dr. SILVERSTEIN. No; the group in Michigan is not. There is a small group of people there who have been interested in the sounding rocket field for some time in much the same way that Van Allen has been working in Iowa, and they have been working in Michigan.

Mr. THOMAS. They are in the manufacturing end of it?

Dr. SILVERSTEIN. Their manufacturing part will be done by Curtiss-Wright Corp. as a part of the group. It is a combined group.

Mr. THOMAS. Is there any competition in this field with regard to price?

Dr. SILVERSTEIN. We already have four sound proposals in the area.

Mr. YATES. Is there a difference in the prices between the four?

Dr. SILVERSTEIN. They are not wide variations. There are some, but they are quite close together, and amazingly so.

Mr. THOMAS. You bought 50 for 1959. How many of them will you fire?

Dr. SILVERSTEIN. There is a long leadtime involved in these vehicles. In other words, you buy them and have to wait until you get them because they take time to produce. I think in 1959 we aim to fire about 30, and the remainder will be fired in early 1960, because it takes time after you buy them to get the vehicle on hand and fitted out with instruments.

Mr. THOMAS. Who makes the instruments or the payloads?

Dr. SILVERSTEIN. The instruments are created both inside our laboratory and outside. I would say that maybe 20 percent of the instrumentation is done in our house and about 80 percent out.

Mr. THOMAS. You do not have any firm bid or contracts on any of this equipment for 1960?

Dr. SILVERSTEIN. No, sir; we do not have the money to do it. Until we get the money we cannot let firm contracts.

Mr. THOMAS. Do you have any bids?

Dr. SILVERSTEIN. Not for the funds we propose to obligate in 1960; we do have firm figures on our 1959 contracts.

Mr. THOMAS. Do you have any of them available with you now?

Dr. SILVERSTEIN. No, sir; but we can make them available to you if you wish.

Mr. WYATT. We do have a body of experience generated this year. We put under contract about $1.2 million this year.

Mr. THOMAS. What will be your unobligated balance in this program at the end of 1959?

Mr. ULMER. The end of 1959 unobligated balance will probably be zero, sir. Out of the total of $204 million in the "Research and development" appropriation we have under contract to date about $140 million; an additional $24 million is committed and ready for contract.

Mr. THOMAS. What became of the $5 million in the sounding rocket program?

Mr. ULMER. In that program we have under obligation $2 million, and there are pending commitments for an additional $1.51 million.

That means the contractual procedures have been completed and all that is required is the formal execution of the contracts.

Mr. THOMAS. With reference to this $1.5 million which is left, what are you going to do with that?

Mr. ULMER. That will be obligated by the end of the year for additional rockets and payloads.

Mr. THOMAS. What is the leadtime required after you put in your order to get one of these?

Mr. ULMER. This varies very greatly with the type of rocket concerned. Some of the off-the-shelf items we can get in 60 days, and others that have to be developed require 6 or 10 months; some a year and a half. This is what Dr. Silverstein meant when he said that they were long leadtime items.

Mr. THOMAS. How many can you get out of Sears, Roebuck's catalog?

Dr. SILVERSTEIN. There are some on-the-shelf items but not over 40 percent of that type. The rest have to be manufactured to specification.

Mr. THOMAS. With reference to one of those that you get off the shelf, what is the average price?

Dr. SILVERSTEIN. These rockets vary in size tremendously. You, perhaps, have been down at Wallops Island Station and have seen some of these rockets in storage. Some of them are this big [indicating], and some this big.

Of course, their heights vary with their diameter. They vary in price from $2,000 up to $30,000, depending on the size of the rocket.

SCIENTIFIC SATELLITES

Mr. THOMAS. Put pages 235, 236, and 237 in the record.

(The pages referred to follow:)

SCIENTIFIC SATELLITES

Fiscal year 1959	$23,252,000
Fiscal year 1960	22,800,000

1. Objectives

To determine the nature, extent, and dynamical behavior of the earth's outer atmosphere, and its relation to the medium of interplanetary space. To determine and understand the nature, extent, dynamical behavior, and causes of the earth's ionophere. To understand the nature, extent, and temporal variations in the gravitational, magnetic, and electric fields in the vicinity of the earth. To understand the origin, nature, motions, spatial distributions, and temporal variations of particles reaching the vicinity of the earth and having energies appreciably greater than thermal. To investigate the electromagnetic radiations reaching the vicinity of the earth, from gamma rays to radio waves, and to use such observations to extend knowledge of the sun, stars, and matter in space, and of the atmosphere of the earth and other planets. To determine and understand the interrelations among the above-listed phenomena. To determine and understand the environmental conditions encountered in the atmosphere, in space, and in vehicles traversing these regions, and their effects on materials and equipment. To determine the effects of conditions in the atmosphere and space and of flight through these regions on living organisms, and to understand the behavior of such organisms under these conditions.

2. Justification

The projects listed below support the above objectives by providing a series of exploratory measurements intended to give order of magnitude estimates of the quantities under observation, and to probe for new discoveries. The exploratory measurements will be followed by a series of more advanced experiments

designed to make accurate measurements within the ranges indicated by the earlier exploratory investigations. Carrying out a number of the investigations in the NASA Space Projects Center will provide a stable nucleus for the program, while the participation of universities and other research agencies will greatly broaden the base and strength of the total program.

3. Program phasing

The current satellite space research program includes three phases: (*a*) lightweight exploratory payloads for survey-type observations; (*b*) lightweight sophisticated experiments for quantitative measurements; and (*c*) heavier orbiting space laboratories of increased scope and complexity. Initial satellites to be launched in 1959 will carry exploratory IGY experiments that justify repetition. Lightweight sophisticated packages will follow in 1960, to study energetic particles, atmospheric properties, ionospheric characteristics, and geodesy. Heavier payloads, such as stabilized telescopes and atomic clocks will be developed and launched when ready. Exploratory biological experiments will be prepared. Meanwhile, with the help of previous results, additional sophisticated payloads in disciplines including atmospheric and ionospheric structure and composition, energetic particles and magnetic fields, solar radiations, and satellite environment, will be developed and prepared for launching.

The 1959 funds will allow the procurement of six satellite systems using three JUPITER, and two THOR-ABLE boosters. Funds are included for payload design, development, and tests; for reduction and analysis of resultant scientific data; and for collateral theoretical investigations. The 1960 funds provide for the purchase of two additional JUNO boosters as well as the payload systems for the THOR-DELTAS and the JUPITERS.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies	$1,000,000	$3,000,000
Prototypes and operational hardware:		
JUNO II satellite vehicles (5 units)	8,540,000	4,000,000
THOR-ABLE satellite vehicles and payloads (2)	7,120,000	
Satellite payloads	2,850,000	6,150,000
Operations and technical services: Assembly and launch of experimental vehicles and data acquisition, reduction, and analysis	2,742,000	6,650,000
Supplies, equipment, repairs, and alterations	1,000,000	3,000,000
Total	23,252,000	22,800,000

Mr. THOMAS. There is $23,252,000 for last year. You show a slight decrease this year, $22,800,000. This is for scientific satellites. What is the difference between these and the rockets? You say—

to determine the nature, extent, and dynamical behavior of the earth's outer atmosphere and its relation to the medium of interplanetary space.

How much higher are you going with these than you went with your rockets?

Dr. SILVERSTEIN. These are orbiting satellites whereas sounding rockets simply go up vertically and come down.

Mr. THOMAS (reading):

The exploratory measurements will be followed by a series of more advanced experiments designed to make accurate measurements within the ranges indicated by the earlier exploratory investigations.

Are you not using greater distances?

Dr. SILVERSTEIN. The meaning of the word "ranges" as given here does not mean distances but within the measurement framework.

Mr. THOMAS. You are going much greater distances?

Dr. SILVERSTEIN. Yes, to greater heights with larger payloads.

Mr. THOMAS (reading):

Carrying out a number of the investigations in the NASA Space Projects Center will provide a stable nucleus for the program, while the participation of universities and other research agencies will greatly broaden the base and strength of the total program.

How much of this money are you going to spend with schools and colleges? Every time we have a program we have to broaden the base. We see that over in the National Science Foundation. We start a fellowship program and pay the universities more than we do the fellows. What part of this is going to the universities to broaden the base?

Dr. SILVERSTEIN. Some money will go—in answer to an earlier question, to support Van Allen—instruments Van Allen develops will be paid for out of these funds. Some of the people at Michigan will participate. There will also be within our industrial framework certain groups who have capability to do this work. They will build some of the payloads.

Mr. THOMAS. This is research. "While the participation of universities and other research agencies will greatly broaden the base and strength of the total program." Are you going to do this at your center? What part of it and where?

Mr. WYATT. We have a vehicle that will be launched within the next couple of months containing within a single package a number of experiments. One we procured from Dr. Van Allen——

Mr. THOMAS. Give us your name.

Mr. WYATT. My name is Wyatt.

Mr. THOMAS. How old are you?

Mr. WYATT. 40.

Mr. THOMAS. Where did you go to school?

Mr. WYATT. University of Missouri, School of Mines and Metallurgy. I worked for General Electric for several years, taught at the university for several years, went with NACA in 1944.

Mr. THOMAS. How long were you with NACA?

Mr. WYATT. Fifteen years.

Mr. THOMAS. You jumped right out of school and went with NACA. We are delighted to have you.

Mr. WYATT. In this single satellite vehicle which will be launched in a couple of months we have an experiment built by Dr. Van Allen at the University of Iowa, another experiment built by Dr. Suomi at the University of Wisconsin, another experiment by Dr. Friedman from the Naval Research Laboratory, and a fourth from Dr. Groetzinger, who died just a few weeks ago, at the Martin Aircraft Co.

Each of these four different sources supplies a part of the total payload. The whole payload was integrated in this case by ABMA. They had responsibility for putting it together.

Mr. THOMAS. Who do you have in your shop who will do this work? Now that you have Dr. Van Allen and that crowd, you do not need anybody here. You just need good mechanics.

Dr. SILVERSTEIN. This is a new field and there have been a few people in this country who laid down the background and developed some new instruments which it takes to do the job. These are not simple but involve the most difficult instrument design, but more than that, new principles.

We have aboard people who have created this art. Now we are teaching other people how to do it. There are people out in industry and universities who have acquired the art but they are not large in numbers. They will be the core group.

Mr. THOMAS. How are you going to spend this money? How much is guesswork? Supplies and equipment, $3 million. You have four classifications. Where are you going to spend your money? How much will you spend in your own institution? How much will you spend with Dr. Van Allen and the other three gentlemen? What do you expect to get for it? You have a lot of money here.

Dr. SILVERSTEIN. You will recall the program we showed on the chart that involved firing some 38 payloads in the next 2 years and 10 months. These payloads have to be developed. We know what they are, we know what are the instruments in them, we know how to specify these instruments, and we know about what they are going to cost. There is some experience in this field.

Mr. THOMAS. Let me read this:

> The 1959 funds will allow the procurement of six satellite systems using three JUPITER, and two THOR-ABLE boosters. Funds are included for payload design, development, and tests; for reduction and analysis of resultant scientific data; and for collateral theoretical investigations. For 1960 funds provide for the purchase of two additional JUNO boosters as well as the payload systems for the THOR-DELTAS and the JUPITERS.

What are you going to spend? Each one will not cost you $4 million?

Dr. SILVERSTEIN. The costs of these things have been established by our experience. For example, in this JUNO II vehicle program we talk about, we know exactly what it will cost because it is priced to us already. This is being done by the ABMA organization.

Mr. THOMAS. How many are you going to fire in 1959? How many have you fired to the present time in 1959?

Dr. SILVERSTEIN. Let us take out the chart.

Mr. THOMAS. How many of them have you instrumented?

Dr. SILVERSTEIN. In the scientific satellites we show on the chart the number of vehicles that will be fired in 1959.

Mr. THOMAS. Do I have this chart?

Dr. SILVERSTEIN. No, but I can make it available to you.

Mr. THOMAS. Tell us how many you have fired this year, what payloads you had in them, where you procured it, what it cost. You know more about that than all of us put together.

Dr. SILVERSTEIN. Fine. We in this year, you will recall, had a firing that went past the moon out into space. This was a JUNO II vehicle initially purchased by ARPA.

Mr. THOMAS. You did not pay for this job?

Dr. SILVERSTEIN. We paid for it by transfer of funds from ARPA to us. This was one of a series of vehicles contracted for with ABMA as a group. You will recall the President asked that five vehicles be prepared for shots toward the moon, three of which were JUNO II.

Mr. THOMAS. What did that one shot cost you? Break it down with your instrumentation, fuel, hardware. You do not charge any salaries and expenses in here.

Dr. SILVERSTEIN. No salaries and expenses. This was a contract arrangement with ABMA in the case of this one firing.

Mr. THOMAS. Who is ABMA?

Dr. SILVERSTEIN. Army Ballistic Missile Agency at Huntsville.

Mr. THOMAS. They are the ones who really originated it. There was a transfer of funds to you after the show was over and what was left they transferred.

Mr. OSTERTAG. Will the Chairman yield?

Mr. THOMAS. Mr. Ostertag.

Mr. OSTERTAG. ARPA transfers the funds to you and then you enter a contract with ABMA and you transfer the money to Army.

Dr. SILVERSTEIN. In this case you recall there was an interim period in which ARPA was given authority to conduct the civilian work until such time as Congress would establish a civilian agency.

Mr. THOMAS. What did it cost to do the complete job? What did ARPA spend?

Dr. SILVERSTEIN. It was between $4 and $4½ million.

Mr. THOMAS. When they shoot the next one, does that cost remain the same? When we build an airplane the prototype may cost $30 or $40 million, but when you build a few, you might get it down to between $10 and $12 million.

Dr. SILVERSTEIN. The payloads in these vehicles are different.

Mr. THOMAS. The vehicle is not different.

Dr. SILVERSTEIN. The vehicle is the same, but basically we have the cost of the vehicle, upper stages, firing costs, payload costs, the acquiring of the data, and the analysis of data.

Mr. THOMAS. Break those down, acquiring data, payload cost, the rocket cost itself, et cetera. You have about four big classifications. You have everything except salaries and expenses. If it cost $4 million, how is that $4 million divided among those four?

Dr. SILVERSTEIN. I will have to do this roughly.

Mr. THOMAS. You can straighten it out in the record.

Dr. SILVERSTEIN. I would say the vehicle and its firing is in the order of $2.2 million for the JUNO II.

Mr. THOMAS. That is a vehicle and its fuel?

Dr. SILVERSTEIN. Yes, and the cost of the actual firing operation, the launching of it at Cape Canaveral.

Mr. THOMAS. That is salaries and expenses.

Dr. SILVERSTEIN. To some organization, but to us it is a contract, not our people. The payload, I would say, roughly costs in the neighborhood of $1,100,000.

Mr. THOMAS. You mean the Van Allen money?

Dr. SILVERSTEIN. Not just Van Allen money, it is a matter of putting it together. This is an instrument that goes into it. This payload is a package that has to have with it telemetry to return this information to earth. It gets to be a real complicated piece of equipment. You have seen these.

Mr. THOMAS. That is $3,200,000. What will happen to the other $8 million?

Dr. SILVERSTEIN. $800,000 is associated with the collection of data, the analysis of data and workup of the data so that things we have learned——

Mr. THOMAS. You have those at your stations. They can take care of a thousand. You are not going to charge $800,000 for one firing on that equipment.

Dr. SILVERSTEIN. You ought to be aware that there are many people in this business of acquiring data. We have, for example, radio dishes at Goldstone picking up data. If we go there after one of these firings, in one case we found a hundred miles of tape to be analyzed. This is the stuff that comes out of the machinery running during the time of this firing collecting data. This tape has to be studied to find out what the data is. There are stations that have to be located at Puerto Rico to find out how this satellite is ejected into its orbit. We have telemery data picked up throughout the world.

Mr. THOMAS. You have 10 or 12 stations from the IGY and you will establish 3 or 4 more?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. Are you putting this cost in already on it?

Dr. SILVERSTEIN. We have a cost involved in the construction of these new stations but we also have a cost for making data available.

Mr. THOMAS. Is that separate from this?

Dr. SILVERSTEIN. I want to make sure you recognize it. We do have the problem of dealing with the data we get back. There is no sense firing these things unless you study the data and make it available.

Mr. THOMAS. You are right. You have $800,000 here.

Dr. SILVERSTEIN. Approximately.

Mr. THOMAS. I imagine that is about $700,000 on the plus side, is it not?

Dr. SILVERSTEIN. I think you are wrong about that.

Mr. THOMAS. You are not buying this equipment. You have already bought it. If you were buying it, I would say so. This is all rental money, is it not? Do you buy it or rent it?

Dr. SILVERSTEIN. Computing equipment?

Mr. THOMAS. Yes.

Dr. SILVERSTEIN. You rent that, of course. That data gets handled in several places. It needs to be handled first by reduction from the electronic impulses sent out by the satellites. These are fed into a machine and reduced so that we call it a rough reduction of data. After that they go out to the investigator to be studied so he can abstract the information from these data and from calculations he has made previously.

Mr. THOMAS. That comes under salaries and expenses now.

Dr. SILVERSTEIN. No, sir. These analyses are done by contract.

Mr. WYATT. For example, Dr. Van Allen will do the final reduction on the data of the experiment he is responsible for.

Mr. THOMAS. Himself?

Mr. WYATT. Himself, or his staff people working with him at the University of Iowa will reduce the data. We furnish him with the initially reduced raw data.

Mr. THOMAS. Do you do it on a yard basis?

Dr. SILVERSTEIN. It really comes down to a matter of how many people are involved in the whole process and our best way of getting at this information is what it is costing us to get it done. We have several different groups working on this.

Mr. THOMAS. You have this tape. It is liable to be a couple thousand yards or 5,000 yards. What yardstick do you go by?

Dr. SILVERSTEIN. We pay what it takes to do the job. We have no other yardstick. In some cases it is less, some more. For example,

you might find some of this data is of no interest, you pass up yards of it. Other parts, you need it all. We do have knowledge as to what it costs because of what it has cost in the past. We have no better ground than that.

Mr. THOMAS. What did it cost you to analyze your data on the big firing you did, your JUPITER?

Dr. SILVERSTEIN. The JUNO was about $700,000 to $800,000 in the breakdown I have given you. This is for completion of the project.

Mr. THOMAS. How would you break down that figure?

Dr. SILVERSTEIN. I do not know that I can break it down much further without digging into the detailed records.

Mr. THOMAS. You do not mind if we do a little guessing with you?

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. You guessed $22,800,000. Suppose we guess.

Dr. SILVERSTEIN. I do not think this is guess.

Mr. THOMAS. You mean it is pretty accurate?

Dr. SILVERSTEIN. I think it is quite accurate.

LUNAR PROBES

Mr. THOMAS. Take your lunar probe, pages 238, 239, 340, and 241; give your breakdown. We will insert them at this point.

(The pages referred to follow:)

LUNAR PROBES

Fscal year 1959	$7,720,750
Fiscal year 1960	7,140,000

1. Objectives

To develop vehicles and associated systems with advancing capabilities for the scientific investigation of space phenomena out to the distance of the moon and of the moon itself; and to utilize such vehicles for the acquisition of fundamental information on the radiation field, and particle properties of cislunar space, and on the mass, configuration, surface details and composition, structural features and dynamics, atmospheric composition and density, magnetic and gravitational fields, radioactivity, biological systems, and other scientific characteristics of the moon.

2. Justification

Recent investigations in the space regions within an earth radius of the surface by means of vertical sounding rockets and earth satellites have already greatly extended man's knowledge of physical and chemical phenomena constituting the earth's environment and exposed important new processes that warrant more detailed investigation. Information of this type is a basic requirement for the understanding of problems concerning meteorology, communications, cosmology and biophysics. Advancement of knowledge in these areas will require, in addition to an intensification of sounding rocket and earth satellite investigations, an extension of environmental measurements to much greater distances from the earth.

As part of this outer environment, and as our nearest major body in the solar system, the moon itself offers important potentialities for better understanding of historic and contemporary phenomena of the solar system and for clarification of some basic physical, chemical, and biological concepts that are fundamental to modern science.

Space flight systems can provide a revolutionary capability for investigation of such problems. A prominent phase of the NASA space flight program will, accordingly, be directed to the development and utilization of space vehicles for the advancement of scientific knowledge concerning cislunar space and the moon itself.

3. Program phasing

As approved by the President, the DOD Advanced Research Projects Agency undertook the development and construction of three THOR–ABLE and two JUNO II lunar and cislunar space probes. On establishment of the NASA these projects were assigned for final funding by the NASA during the fiscal year 1959. These probes are permitting evaluation of initial problems associated with the placing of space vehicles in circumlunar trajectories and in loose satellite-like orbits about the moon, and should provide some preliminary information on the environmental characteristics of cislunar space and, possibly, certain gross characteristics of the moon itself.

During the fiscal year 1959, work will be initiated on the development of advanced probes with improved capabilities for conducting cislunar space investigations and for evaluating the problems involved in establishing vehicles in more precise lunar orbits as the first step in acquiring more detailed information on lunar characteristics. Advancement of the technology of midcourse guidance and long-distance data transmission is basic to the success of this mission and emphasis will be placed on the resolution of these problems.

The project will be continued in the fiscal year 1960, and as system development is completed, launchings of precision lunar orbiters will be scheduled. In addition to the demonstration of vehicular capabilities, such probes should provide advanced information on cislunar and lunar magnetic fields, micrometeoritic distributions, and radiation and cosmic particle properties. It is hoped that improved information on lunar mass will be provided and high-resolution mapping of the moon's surface achieved.

Studies and preliminary development projects will be undertaken in the fiscal year 1959 and extended in the fiscal year 1960 to acquire technology for a more advanced lunar vehicle with a capability for executing a controlled lunar landing. Such a vehicle would provide important potentialities for detailed scientific exploration of local physical, chemical, and biological characteristics of the moon. Investigations of terminal guidance systems, orientation devices, landing controls and motors, robot erecting and experiment mechanisms, and special scientific sensors will be required. It is not expected that such vehicles will be available for launching before 1961.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Basic investigations to develop advanced mid-course guidance, orientation, scientific sensor, command control and data handling and transmission components and systems	$575,000	$1,000,000
Basic investigations to develop terminal guidance systems, landing controls and motors, robot mechanisms, and special scientific sensors for lunar landing vehicles	300,000	800,000
Prototypes and operational hardware:		
Balance of funding for construction and flight tests of three Thor-Able and two Juno II lunar probes transferred from ARPA	4,810,000	
Research, development, and construction of advanced mid-course guidance and control, scientific sensors, and data handling and transmission systems for lunar probe payloads	1,500,750	3,100,000
Operations and technical services:		
Assembly and launch of experimental vehicles and data acquisition, reduction, and analysis	285,000	1,240,000
Supplies, equipment, repairs, and alterations	250,000	1,000,000
Total	7,720,750	7,140,000

Mr. THOMAS. Where did your 1959 funds come from; where and how much? Are these transferred funds?

Mr. WYATT. Part of them, sir.

Mr. THOMAS. Are these transferred funds or your 1959 funds?

Mr. ULMER. As you know, approximately $154 million of our total R. & D. budget this year comes from transferred money; $57.8 million of that came from the Air Force, $67.2 million from ARPA, a little over $25 million from the Navy on the VANGUARD program, about $4 million from the Army.

Mr. THOMAS. The answer is it is all transferred funds?

Mr. ULMER. Not necessarily all, but a good part of it comes from transferred money.

Mr. THOMAS. It is bound to.

Mr. ULMER. $154 million out of the $204 million.

Mr. THOMAS. Your scientific satellites, that is bound to come from transferred money.

What was given you last year in the research and development appropriation?

Mr. ULMER. $50 million.

Mr. THOMAS. You have just about used that $50 million for the programs in this book now. From here on it is bound to come out of the transferred funds.

Mr. ULMER. Fair enough.

Mr. THOMAS (reading):

To develop vehicles and associated systems with advancing capabilities for the scientific investigation of space phenomena out to the distance of the moon and of the moon itself; and utilize such vehicles for the acquisition of fundamental information on the radiation, field, and particle properties of cislunar space, and on the mass, configuration, surface details and composition, structural features and dynamics, atmospheric composition and density, magnetic and gravitational fields, radioactivity, biological systems, and other scientific characteristics of the moon.

Recent investigations in the space regions within an earth radius of the surface by means of vertical sounding rockets and earth satellites have already greatly extended man's knowledge of physical and chemical phenomena constituting the earth's environment and exposed important new processes that warrant more detailed investigation. Information of this type is a basic requirement for the understanding of problems concerning meteorology, communications, cosmology, and biophysics.

It might be worth reading this:

Space flight systems can provide a revolutionary capability for investigation of such problems. A prominent phase of the NASA space flight program will, accordingly, be directed to the development and utilization of space vehicles for the advancement of scientific knowledge concerning cislunar space and the moon itself.

As approved by the President, the DOD Advanced Research Projects Agency undertook the development and the construction of three THOR-ABLE and two JUNO II lunar and cislunar space probes. On establishment of the NASA these projects were assigned for final funding by the NASA during the fiscal year 1959. These probes are permitting evaluation of initial problems—

and so on.

You set out your project down here:

During the fiscal year 1959, work will be initiated on the development of advanced probes with improved capabilities—

How many have you done to date?

Dr. SILVERSTEIN. There were five attempts to reach the moon, two of them could be considered only partially successful, one went out to 63,000 miles, one to 71,000 miles, and one went past the moon.

Mr. THOMAS. Did the 62,000- and 71,000-mile shots occur after we took over?

Dr. SILVERSTEIN. After NASA took over.

Mr. THOMAS. I said "we."

Dr. SILVERSTEIN. We.

Mr. YATES. Is this third one in orbit around the sun?

Dr. SILVERSTEIN. Yes, sir.

Mr. BOLAND. Do you know that it is now orbiting? Do you get information from it now?

Dr. SILVERSTEIN. We get no information, but it has to orbit. In space it has to follow the laws of spatial mechanics.

Mr. BOLAND. It is going to orbit forever?

Dr. SILVERSTEIN. Yes, unless it is in some fashion knocked out by a meteorite larger than it is.

Mr. THOMAS. There is no friction to disintegrate it? How do you know? Have you been there recently? If we know these things, why send them up?

Mr. WYATT. That is why we want to send some of these things up.

Mr. ABBOTT. Eventually, it would probably evaporate.

Mr. YATES. How many years?

Mr. ABBOTT. If we knew that, we would not have to find out.

Mr. THOMAS. What material did you make it out of? Was it titanium, plated with gold, or what?

Dr. SILVERSTEIN. Titanium plated with gold.

Mr. RHODES. Pretty expensive stuff.

Dr. SILVERSTEIN. The case is the least expensive part of it.

Mr. THOMAS. What was the object in using those two metals?

Dr. SILVERSTEIN. Titanium is strong and light. Gold was used because the surface was part of the antenna system and was a conductor.

Mr. THOMAS. That titanium is for your toughness, strength, and lightness?

Dr. SILVERSTEIN. Yes, sir.

Dr. GLENNAN. That is the shot that we were able to get intelligence back from for 406,000 miles with a unit that weighed only 13.4 pounds. That is in comparison with the Russians. Their unit weighed 794 pounds, they say, and they went out to about 370,000 miles with their transmission.

Mr. THOMAS. How far?

Dr. GLENNAN. 32,000 miles less.

Mr. THOMAS. And how much weight?

Dr. GLENNAN. They had about 60 times as much weight.

Mr. THOMAS. All it proves is they have a greater thrust. It does not prove the instrumentation was any good.

The project will be continued in the fiscal year 1960, and as system development is completed, launchings of precision lunar orbiters will be scheduled. In addition to the demonstration of vehicular capabilities, such probes should provide advanced information on cislunar and lunar magnetic fields, micrometeoritic distributions, and radiations and cosmic particle properties. It is hoped that improved information on lunar mass will be provided and high resolution mapping of the moon's surface achieved.

Studies and preliminary development projects will be undertaken in the fiscal year 1959 and extended in the fiscal year 1960 to acquire technology for a more advanced lunar vehicle with a capability for executing a controlled lunar landing. Such a vehicle would provide important potentialities for detailed scientific exploration of local physical, chemical, and biological characteristics of the moon. Investigations of terminal guidance systems, orientation devices, landing controls and motors, robot erecting and experiment mechanisms, and special scientific sensors will be required. It is not expected that such vehicles will be available for launching before 1961.

You set out a bunch of figures. What are the figures here? I have down here, Dr. Van Allen, $3,100,000. You say "Basic investigations to develop advanced midcourse guidance, $1 million." You spent $575,000. Is that a one-shot proposition?

Mr. WYATT. No, sir; this is basic study of the problem area. The midcourse guidance refers to the fact that after you get part way out to the moon you verify whether you are on the right path or not, and if you are not, you correct the path at that point. You do it in midcourse as soon as you can so that you do not carry this guidance weight farther.

Mr. THOMAS. How did you spend $575,000 on that proposition?

Mr. WYATT. This goes into applied research and development contracts. The principles we need first to learn and then we need to get lightweight effective guidance systems; and finally, get this guidance intelligence incorporated in the space vehicle system.

Mr. ULMER. This would be several contracts.

Mr. THOMAS (reading):

> Basic investigations to develop terminal guidance systems, landing controls and motors, robot mechanisms, and special scientific sensors for lunar landing vehicles.

You must have a half dozen contracts here.

Mr. ULMER. It could well be that many.

Mr. THOMAS. How much of the $7½ million from last year have you obligated?

Mr. ULMER. About $5 million.

Mr. THOMAS. Who are your contractors?

Mr. ULMER. The AOMC of the Army, the Ballistic Missiles Division of the Air Force, the Navy, and the Bureau of Standards.

Mr. THOMAS. Ballistic Missiles Division of what?

Mr. ULMER. Air Force.

Mr. THOMAS. Where do they do the work?

Mr. ULMER. Primarily at Douglas Aircraft and the Space Technology Laboratories. Then there is the AOMC of the Army at Huntsville; we have a contract with the Office of Naval Research and with the Naval Ordnance Test Station at Inyokern, Calif.

Mr. THOMAS. What was the sum total of your contracts?

Mr. ULMER. $4.96 million.

Mr. THOMAS. Where were the two big ones?

Mr. ULMER. AOMC, Army, and the Ballistic Missile Division of the Air Force, for a total of $4.6 million.

Dr. SILVERSTEIN. You will recall that the two firings toward the moon we completed paying for in 1959 were made by the Army and three of them were made by the Air Force.

Dr. GLENNAN. Using THOR vehicles.

Dr. SILVERSTEIN. These firings were made after NASA took over the programs.

Mr. THOMAS. These are transferred funds?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. Is this a continuing proposition here on your guidance system?

Dr. SILVERSTEIN. This is a small downpayment in this area. I do not know whether you are familiar with the amount of money spent in guidance for things such as ballistic missiles.

Mr. THOMAS. How much is it?

Dr. SILVERSTEIN. Hundreds of millions of dollars spent in this area. Our space guidance systems must in a sense be more advanced than those systems.

Mr. THOMAS. How are they guided? Explain in your own way. You fire one of these missiles and are going to try to reach the moon. How do you guide it.

Dr. SILVERSTEIN. You start off by establishing the path you want the missile to follow. Then your first booster, for example, has within it a guidance system made up initially of a gyroscopic table, which will always hold its plane of reference with respect to the initial setting. You have seen gyroscopes that will always stay in the same plane at which they are set. You program a flight with reference to this fixed platform, you program a certain motion of the vehicle. As it moves along its flight path, this program is arranged to move the rocket motors to apply a thrust in a certain direction so that you guide the vehicle along this set program.

You guide it into this orbit or into this trajectory if you want the thing to fly.

Mr. THOMAS. It carries its own guidance system?

Dr. SILVERSTEIN. Yes, sir. Currently the position we are in is that after the first vehicle fires and the rocket motor stops burning we have been spinning the upper stages and, in a sense, making a gyroscope out of the upper stages by spinning them. After they once release from the main booster, they no longer have guidance in them. Whatever they have as guidance is established at the moment of separation.

In our advanced vehicles that we are developing now we want more accuracy than we can establish by this principle, so we are putting a guidance system in this upper stage.

Mr. THOMAS. So it is controlled all the way?

Dr. SILVERSTEIN. All the way. We missed the moon the last time by 37,000 miles. We want to do better than that. You cannot do better than that using these old-style vehicles. We have to get guidance in the upper stages. We know how to do it generally, but there are major developments of hardware between knowing how to do it and doing it.

Mr. THOMAS. Suppose that missile gets too far off the track and you want to explode it and bring it down. How do you do it?

Dr. SILVERSTEIN. You put an explosive charge in and have a command radio. You send a signal from the ground by radio to the missile and say, essentially, "Light the fuse." This turns the keys in the explosive and blows up the vehicle.

Mr. THOMAS. $1,240,000 for acquisition, reduction, and analysis of your data. Of course, that is a guess figure. What about your supplies, equipment, repairs, alterations, in round figures of a million dollars? How do you arrive at that figure?

Dr. SILVERSTEIN. This is based on experience.

Mr. THOMAS. You have only fired two, and you figure on the basis of firing two? You are going to fire how many with this $7 million, six or eight or five?

Dr. SILVERSTEIN. There will be from these funds some five payloads developed.

DEEP SPACE PROBES

Mr. THOMAS. Deep space probes. Put pages 242, 243, and 244 in the record.

(The pages referred to follow:)

Deep-Space Probes

Fiscal year 1959 ---------- $17,791,000
Fiscal year 1960 ---------- 6,803,500

1. Objectives

To develop vehicles and associated systems with advancing capabilities for the scientific exploration and evaluation of deep-space phenomena; and to utilize such vehicles for the acquisition of fundamental information on the constituents, processes, and characteristics of the solar system, particularly as they influence the geophysical, astrophysical, and cosmological sciences.

2. Justification

Man's effort to identify, understand, predict, use, and possibly control elements of his natural environment must take into account the numerous factors and influences associated with the cosmic domain. Until recently, progress along these lines has been subject to the limitations imposed by remote observations and indirect measurements. Space flight vehicles now offer an important research capability for circumventing many of these limitations and thereby permitting verification, clarification, and vast extension of existing information on space phenomena.

In particular, instrumented vehicles of appropriate design may explore the variation of pertinent physical and chemical characteristics of space with distance from the sun and provide a wealth of fundamental information on the spatial distribution, nature, magnitude, dynamics, temporal variations, and interactions of micrometeorites, energetic particles, electromagnetic radiations, magnetic fields, electrons, ions, hydrogen, and the sun's atmosphere in the solar system, and on their relation to phenomena experienced on earth. Investigations of the major bodies of the solar system themselves should provide further insight into the relative characteristics of various components of the system, the influence of particular environments on planetary physics, chemistry, and biology, and on the historic and contemporary processes of the solar system.

3. Program phasing

During the fiscal year 1959 a project is being undertaken to develop an initial vehicular system with potentialities for flight to the vicinity of the Venus orbit on essentially a minimum-energy trajectory. Two vehicles, one based on the THOR-ABLE and the other on the ATLAS-ABLE propulsion systems will be constructed. It is anticipated that guidance, tracking, and data transmission will be crucial to this operation. Accordingly, while it is planned that some scientific instrumentation will be carried to provide preliminary information on radiation, particle, and field characteristics along the flight path of the vehicle, considerable emphasis will be placed on the demonstration and evaluation of system requirements for future deep-space experiments. Concurrently, study and development projects will be undertaken to provide improved vehicular subsystems and operating techniques with refined and extended capabilities for more advanced experiments.

During the fiscal year 1960 the VEGA vehicle system will be under development. Such a vehicle will make possible a wider range of scientific missions by offering a greater payload carrying capacity, and/or sufficient energy to penetrate to greater distances toward or away from the sun. Development and construction of the advanced guidance, the instrumentation, and the data handling and data transmission systems which will be used in the payloads for such missions will also be undertaken. It is not expected that the advanced probes will be available for launching before 1961.

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4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Investigations of advanced midcourse guidance and control, tracking, and data handling and transmission systems	$840,000	$850,000
Investigations of scientific instrumentation for evaluating planetary and deep space characteristics	800,000	800,000
Prototypes and operational hardware:		
Development, construction, and launch of initial THOR-ABLE and ATLAS-ABLE deep space probes (2)	8,990,000	----------
Development of advanced midcourse guidance and control, data handling and transmission and instrumentation systems for deep space payloads	6,401,000	3,653,500
Operations and technical services:		
Assembly and launch of experimental vehicles and data acquisition, reduction and analysis	600,000	1,000,000
Supplies, equipment, repairs, and alterations	160,000	500,000
Total	17,791,000	6,803,500

Mr. THOMAS (reading):

To develop vehicles and associated systems with advancing capabilities for the scientific exploration and evaluation of deep space phenomena; and to utilize such vehicles for the acquisition of fundamental information on the constituents, processes, and characteristics of the solar system, particularly as they influence the geophysical, astrophysical, and cosmological sciences.

Man's effort to identify, understand, predict, use, and possibly control elements of his natural environment must take into account the numerous factors and influences associated with the cosmic domain. Until recently progress along these lines has been subject to the limitations imposed by remote observations and indirect measurements. Space flight vehicles now offer an important research capability for circumventing many of these limitations and thereby permitting verification, clarification, and vast extension of existing information on space phenomena.

Last year you spent $17,791,000, this year $6,803,500. Did you produce very much of interest to you last year? You say on page 243:

During the fiscal year 1959 a project is being undertaken to develop an initial vehicular system with potentialities for flight to the vicinity of the Venus orbit on essentially a minimum-energy trajectory. Two vehicles, one based on the THOR-ABLE and the other on the ATLAS-ABLE propulsion systems will be constructed. It is anticipated that guidance, tracking, and data transmission will be crucial to this operation. Accordingly, while it is planned that some scientific instrumentation will be carried to provide preliminary information on radiation, particle, and field characteristics along the flight path of the vehicle, considerable emphasis will be placed on the demonstration and evaluation of system requirements for future deep-space experiments. Concurrently, study and development projects will be undertaken to provide improved vehicular subsystems and operating techniques with refined and extended capabilities for more advanced experiments.

During the fiscal year 1960 the VEGA vehicle system will be under development. Such a vehicle will make possible a wider range of scientific missions by offering a greater payload carrying capacity and/or sufficient energy to penetrate to greater distances toward or away from the sun. Development and construction of the advanced guidance, the instrumentation, and the data handling and data transmission systems which will be used in the payloads for such missions will also be undertaken. It is not expected that the advanced probes will be available for launching before 1961.

How far are we going on this one? We went past the moon on the others. How much farther?

Dr. SILVERSTEIN. If we try to go to Venus we talk about total distances that can be in the order of——

Mr. THOMAS. With the VEGA you are going past Venus.

Dr. SILVERSTEIN. With the VEGA perhaps one of the first missions might be aimed toward Mars.

Mr. THOMAS. The reason you jump from $17,791,000 is you have two in 1959. Next year you are going to reduce the unit cost and are going farther and have a little bigger thrust, more instrumentation. You will use one, but you will cut your unit cost down to less than $7 million; is that correct?

Dr. SILVERSTEIN. I think there is some explanation needed here for the difference in these costs. In this 1959 budget we carried within the framework of the budget the vehicles that were used for the firings.

Mr. THOMAS. Did ARPA start this 1959 project for you?

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. You inherited it from them? This is Army—Dr. von Braun?

Mr. WYATT. No, sir; this is Air Force Ballistic Missile Division, THOR and ATLAS vehicles. Dr. von Braun works with the JUPITER vehicles.

Mr. THOMAS. Who were the scientists responsible on this program?

Mr. WYATT. The Space Technology Laboratory.

Dr. DRYDEN. Louis Dunn.

Mr. YATES. Does the Air Force have anybody to compare with Dr. von Braun to whom they point?

Mr. THOMAS. They think Dunn is good, too.

Dr. GLENNAN. And Andrew Mettler.

Dr. SILVERSTEIN. This is the organization that Jimmy Doolittle is heading up now.

Mr. THOMAS. What do you mean?

Dr. SILVERSTEIN. He is chairman of the Space Technology Laboratory organization.

Mr. THOMAS. Is this all by contract with him or with his organization?

Dr. SILVERSTEIN. The work we are doing here is a contract with the Ballistic Missile Division. The Space Technology Laboratories serve as a technical arm of the Ballistic Missile Division.

Mr. THOMAS. Where does General Doolittle come in? I notice he used to be on our advisory committee. How did the Air Force spend their $18 million for this project? Was it in their own laboratories or did they make a contract with a private company to do this work in 1959?

Dr. SILVERSTEIN. The project is made up of a number of parts. For example, there are THOR boosters. These were purchased from Douglas Aircraft Corp. The second stage is a rocket engine system built by Aerojet Corp. This was contracted with them. The third stage is by the Allegheny Ballistic Missiles Group and the contract was with them for the third stage.

The Space Technology Laboratories put these different pieces together, connected them together, and put in them the guidance system.

Mr. THOMAS. How would you say salaries and expenses compared with the cost of the material, the boosters, the three separate rockets, et cetera? Would that be 60–40, 50–50, or what?

Dr. SILVERSTEIN. I would say salaries and expenses——

Mr. THOMAS. At the laboratory.

Dr. SILVERSTEIN. At the laboratory they were probably 30 percent.

Mr. THOMAS. A third?

Dr. SILVERSTEIN. Thirty percent of the effort.

Mr. THOMAS. Where will you spend your $6,800,000? Is that with General Doolittle?

Mr. WYATT. There will be three VEGA payloads and vehicles represented.

Mr. THOMAS. Where will this money be spent?

Dr. SILVERSTEIN. This money will be spent in different places. The payloads for these vehicles will probably be integrated at our Jet Propulsion Laboratory. The instruments will be obtained from different sources throughout the country.

Mr. THOMAS. No salaries and expense money in here, no part of the $6 million?

Dr. SILVERSTEIN. No.

Mr. THOMAS. This is for materials?

Dr. SILVERSTEIN. Yes, sir. Are we talking about $6 million?

Mr. THOMAS. $6,803,500.

Dr. SILVERSTEIN. No salaries and expenses. All by contract.

Mr. THOMAS. Where does General Doolittle's company come in?

Mr. WYATT. On the 1959 expenditures.

Mr. THOMAS. Where?

Mr. WYATT. The $8,990,000 item on page 244 and $7,120,000 on page 236 under "Scientific satellites."

Mr. THOMAS. Prototypes?

Mr. WYATT. Development, construction and launch of initial THOR-ABLE and ATLAS-ABLE deep-space probes, as shown under "Prototypes and operational hardware."

Dr. DRYDEN. Doolittle just joined the company a few months ago as chairman of the board.

Mr. THOMAS. What is the name of the company?

Dr. DRYDEN. Space Technology Laboratories.

Mr. THOMAS. Where is it located?

Dr. GLENNAN. California.

Mr. YATES. Is this a new company?

Dr. GLENNAN. This is the fallout of Thompson-Ramo-Wooldridge. They separated it out. Probably they will sell it.

Mr. THOMAS. How much business is this crowd getting out of NASA?

Dr. GLENNAN. Just what you saw there.

Mr. THOMAS. No more?

Dr. DRYDEN. We have no contract directly with them. We have contracts with the Ballistic Missile Division, and the Ballistic Missile Division has subcontracts to them for some parts.

Mr. WYATT. $8.99 million does not all go to STL. Part goes to BMD, part to Douglas for THOR, part to Convair for the ATLAS.

Dr. GLENNAN. We have no contract directly with STL. They are a captive organization used pretty completely by the Ballistic Missile

Division of the Air Force. They are the systems management group for them on their missile work.

Mr. THOMAS. It is a unit of Ramo-Wooldridge, then?

Dr. GLENNAN. It was the unit of Ramo-Wooldridge, and the corporate structure was quite changed, I believe, and Space Technology Laboratories is an independent subsidiary of what is now known as Thompson-Ramo-Wooldridge.

Mr. RHODES. It appears from the amount of money being spent that you are slowing up your deep-space probes and your lunar probes, in 1960. Is that true and, if so, what is the reason?

Dr. SILVERSTEIN. I mentioned earlier that in our 1959 funding the vehicles were existing vehicles. They were items that could be purchased from off-the-shelf.

We have carried the existing vehicles within the total funding for this item. In our 1960 program, the newer vehicles are shown separately in the latter part of the R. & D. program, the last set of items.

Mr. RHODES. What is the total figure corresponding to your 1959 figure for deep-space probes; $17,791,000?

Dr. SILVERSTEIN. I would have to add this number up. I think we can add this up.

Mr. WYATT. If we approximate on the initial set of VEGAS, including the development costs of these VEGAS, they will run about $10 million apiece. That is $30 million for three VEGAS plus the sum shown here, $36 million.

Mr. SEIPERT. It might help to look on page 244. The figure of $30 million that Mr. Wyatt gave for the new VEGAS is comparable to the figure for existing vehicles in the middle of that page under "Prototype and operational hardware, $8,990,000." That is the cost of the basic boosters for the payloads.

Mr. THOMAS. What should it be for three VEGAS?

Mr. SEIPERT. You have to add in the developmental costs to build these VEGAS for the first time. They cost much more. It takes the $10 million per vehicle that we talked about to get a much larger payload. This is not a slow-up of this program. Actually it is a substantial progress toward bigger and more useful payloads.

Mr. THOMAS. $17.8 million expenditure, $30 to $36 million instead. What did you get for your $18 million this year?

Mr. WYATT. We have not yet launched the vehicle.

Dr. SILVERSTEIN. You start the vehicles one year and fire them the next.

Mr. THOMAS. When are you going to fire these two? I thought you had already fired one.

Dr. SILVERSTEIN. No, sir; none of these.

Dr. GLENNAN. We still hope to fire them this fiscal year, but we may not be able to. I think it is important to point out we have tried to get away from setting dates and then lighting the fuse on the things just to match those dates.

Mr. THOMAS. And then have the newspapers breathing down your neck.

Dr. GLENNAN. We are trying to control this on a good, sound engineering basis so when we think we have a better than even chance of

getting back the information we set out to get, we will launch, but until that time we will not.

Mr. THOMAS. What did we gain specifically out of the one we shot past the moon. What was that the height?

Dr. SILVERSTEIN. The last one went past the moon and this is out in space now way past the moon, which is 280,000 miles away.

Mr. THOMAS. What did we learn? What instrumentation did we have in it? What do we hope to get out of the VEGAS and out of the one immediately preceding the VEGAS? This is the ultimate step, is it not?

Dr. DRYDEN. Dr. Van Allen just reported on this to the Academy at the meeting yesterday and there is an article in the morning paper and in Time magazine.

On the last shot we discovered that the inner radiation belt had about the same intensity as before, about the same dimensions.

Mr. THOMAS. Is there anything other than the Van Allen two belts?

Dr. DRYDEN. He found the outer belt had changed from the time of the last firing and is connected with an eruption from the sun. He found the new information is that the outer radiation belt extended to much greater distances, higher intensities, and that this is related to an eruption from the sun. There is a direct connection between conditions on the sun and the extent and intensity of the second radiation belt. This is what was discovered about the radiation belt. There are other findings that I do not know that I recall. There was, of course, some instrumentation on micrometeorites which has not shown any difference.

Mr. THOMAS. What about wind current and temperatures?

Dr. DRYDEN. This is out into space, out through our atmosphere.

Dr. GLENNAN. Is not the point we should make with the Chairman that what is bothering you is you fire one of these things, get all the information, why do you do it over again? It is just because the conditions which we are trying to study change with latitude, they change with the activity on the sun, we do not know what else they change with. But if we are going to understand the conditions in the outer atmosphere or outer space, we must really make quite a number of firings at different times of year, different times of day, whatever it may be.

Mr. THOMAS. You learn just what you are instrumented to get and you cannot put all your instruments in one load, can you?

Dr. GLENNAN. No, sir.

Mr. THOMAS. What was the rocket instrumented to find out which went past the moon?

Dr. SILVERSTEIN. There were basically three instruments aboard. The most important was, I think, discussed by Dr. Dryden, the cosmic ray instrumentation, which was designed to tell us the information on this outer belt and beyond. We want to know how far out this radiation extends, and is there some pickup at the moon?

The second thing aboard was a device which was being tried for the first time in anticipation of later programs. For example, we will want to take pictures of the moon and there is a small television camera being developed currently that will be used in later firings, so we can get these pictures as we orbit the moon of the back side of the moon and get the detail of the moon's surface more accurately.

There was a trigger device aboard which was being investigated. This was arranged to open when it passed within a certain distance of the moon. This was another instrument aboard.

The third thing we were interested in was to investigate the communication problems between distant vehicles and the earth, to find out how far we could go out and see whether, with the amount of power we had aboard the satellite, we could communicate from these distances.

Mr. THOMAS. Are you going to make obsolete these big telescopes we have in England, Arizona, and West Virginia?

Dr. SILVERSTEIN. I do not think we will make these obsolete. They are simply a different arm of the science.

Mr. THOMAS. You are trying to gain the same piece of information, are you not, more of what the moon looks like? If you can do it on the ground with a telescope, why go 250,000 miles to try to do the same job?

Dr. SILVERSTEIN. For example, a radio telescope, as an instrument, is not looking so much at the moon but at the distant galaxies and attempting to discover the radiations coming to us down to the earth from the distant galaxies.

The particular dish in West Virginia has another purpose, essentially a military mission. It is disassociated basically from the scientific area we are working in.

VAN ALLEN RADIATION BELT

Dr. DRYDEN. To complete what we learned, Van Allen had a shielded cosmic Geiger counter as well as one which was unshielded. He found less than one-sixth inch of lead was sufficient to protect against this radiation in the outer belt, which is generated by the sun. But he also found that the inner belt was far more penetrating and it would take much more shielding to protect against the inner than the outer belt.

Mr. THOMAS. How did he gather that information?

Dr. DRYDEN. He had two tubes, one of which had a shield of lead around it, and he found when the vehicle was passing through the innermost belt the two read about the same, very little reduction, but when he got to the outer radiation belt——

Mr. THOMAS. This was transmitted back?

Dr. DRYDEN. Yes, by telemetering to the ground.

As to the transmission mechanics, the radio transmitter had a device to measure power and telemetered to earth; by measuring the intensities of the received signal, they could compare what they actually got with what they computed theoretically to see if there were unforeseen losses in between.

Mr. BOLAND. How far was the first belt of radiation?

Dr. GLENNAN. 500 miles.

Mr. BOLAND. How far was the second?

Dr. DRYDEN. 1,500 to 5,500 or 6,000 miles.

Dr. GLENNAN. That is wandering a bit, too. That is why you need to go back and back and back to find out about it.

Mr. BOLAND. The first belt was a hundred miles out and the second was from 1,500—did you say 500 miles out?

Mr. WYATT. The first belt was 400 to 600 miles out.

Mr. THOMAS. It is in the justifications some place. Can anybody put his finger on it?

Mr. WYATT. On what?

Mr. THOMAS. The radiation belts, Dr. Van Allen's discovery.

Mr. BOLAND. Supply it for the record.

(The information requested follows:)

The Great Radiation Belt, frequently known as the Van Allen Belt, is two zones of peak radiation surrounding the earth. Over the equator the inner belt starts at about 500 miles altitude and reaches a peak at about 2,000 miles. This belt gradually reduces in intensity to a minimum value at a distance of 5,000 miles. From 5,000 miles onward is a zone that can be identified as a second belt. This belt reaches a peak intensity at about 10,000 miles from the earth and gradually falls to essentially a free space level of radiation at about 20,000 to 40,000 miles from the earth. These belts are not exactly defined as yet.

VEGA SPACE FLIGHT VEHICLE

Mr. THOMAS. Prototype operational hardware is set out on page 292 at this figure of $38.3 million, is it not? What is the justification of that?

Mr. WYATT. On page 292, sir?

Mr. THOMAS. Yes, sir

Mr. WYATT. This is the cost for the second year.

Mr. THOMAS. Your justifications state as follows:

The VEGA program is divided into five parts: (1) Development and testing of the modified VANGUARD engine; (2) modification of the ATLAS booster; (3) design and fabrication of the second stage; (4) integration of the VEGA vehicle; and (5) testing and launch. Funding of this program, including the procurement of eight vehicles, will be initiated in fiscal year 1959 and continued in fiscal year 1960.

Now, you come on down here with a total cost of $42.8 million, but the prototype cost is $38.3 million. Can you put a breakdown at that figure in the second.

(The information follows:)

The $38.3 million for prototypes and operational hardware under the VEGA space flight vehicle program breaks down as follows:

3 ATLAS boosters	$7,500,000
2d-stage manufacturing and assembly of vehicles	19,000,000
Manufacturing of 2d-stage engines	2,000,000
Manufacturing of 3d-stage of vehicles	9,800,000
Total	38,300,000

Dr. SILVERSTEIN. The VEGA vehicle will be constructed by the Convair Corp.

Mr. THOMAS. Where are they located?

Dr. SILVERSTEIN. In San Diego.

Mr. THOMAS. How much are you spending with them this year, $38 million?

Dr. SILVERSTEIN. $38 million will not all be spent with Convair.

Mr. THOMAS. How much?

And, to make this vehicle more accurate, instead of your spending $6,803,500 on your deep space probe, against $17,900,000 for 1959, it is going to be nearer $42 million?

Dr. SILVERSTEIN. But they do not appear in both places. What has been done there in these earlier justifications was to put in with the

area of scientific effort only those costs for vehicles which are essentially procurable as on-the-shelf items.

These we get from the ABMA or from the Ballistic Missiles Division of the Air Force.

Where we are still in the process of designing, building, and developing improved vehicles such as the VEGA, the SCOUT and CENTAUR, these costs are lumped together under special programs for developing the vehicle. The costs that we show under developing the vehicle do provide a certain number of initial vehicles.

Mr. THOMAS. This $42.8 million is going to procure or develop three?

Mr. WYATT. No, sir, those two sums in 1959 and 1960 are the first 2 years' funding on the cost of the development and procurement of eight VEGA vehicles.

Mr. THOMAS. What are the eight going to cost you when you get through?

Mr. WYATT. The eight vehicles when we get through should cost us around $91.5 million.

Mr. THOMAS. Funding for this program will include the procurement for eight initiated in 1959 and you are spending $22.8 million in 1959?

Mr. WYATT. Yes, sir.

Mr. THOMAS. When will you get delivery on them?

Mr. WYATT. They will begin to be delivered in fiscal 1960.

Mr. THOMAS. Where does that tie into your deep space probe?

Mr. WYATT. Well, sir, the VEGA, once it is developed, will greatly improve our deep space work.

Mr. THOMAS. That is the VEGA vehicles you are going to use here?

Mr. WYATT. Yes; and the total cost for the first eight will be $90 million, or a little over $10 million per vehicle.

Mr. THOMAS. That is the development cost altogether?

Mr. WYATT. Development and procurement of the first eight, and that is the figure I used as being approximately $10 million each.

Mr. THOMAS. For what is this $17.8 million in 1959?

Mr. WYATT. That is for the THOR-ABLE and ATLAS-ABLE vehicles we must use in the immediate probes.

Dr. GLENNAN. If we could throw away that development cost, Mr. Chairman, subsequent units of the VEGA might be said to cost in the neighborhood of what? Four million dollars?

Dr. SILVERSTEIN. That is about the order.

Mr. THOMAS. Does this $17.9 million reflect your development costs for this THOR-ABLE?

Mr. WYATT. No, sir.

Mr. THOMAS. How much additional to the $17.9 million is that?

Mr. WYATT. I beg your pardon? The question was if they reflected the development costs of the THOR-ABLE?

Mr. THOMAS. Yes.

Mr. WYATT. They do not include a development cost because the THOR-ABLE is essentially what we would call an off-the-shelf vehicle.

It was developed by the Air Force.

Mr. THOMAS. You do not know what the Air Force spent on it?

Mr. WYATT. No, sir.

Mr. RHODES. Mr. Chairman, is this VEGA actually a combination of an ATLAS booster and the second-stage VANGUARD?

Dr. SILVERSTEIN. No.

Mr. RHODES. Why do you have to spend $90 million to develop something that is already developed?

Dr. SILVERSTEIN. No; it is not the second-stage VANGUARD. The VEGA is the ATLAS booster modified, plus two new stages above it. You might recall the charts which I showed yesterday.

Mr. RHODES. I am reading here, and it says developing and testing of the modified VANGUARD engine.

Dr. SILVERSTEIN. Yes, sir.

Mr. RHODES. What did you have to do with the engine?

Dr. SILVERSTEIN. The first stage was made by the General Electric Co.

Mr. RHODES. Of course, the thing never worked.

Dr. SILVERSTEIN. The engine works excellently. This first-stage engine has worked all the time, and has a record of some 43 successful firings.

Mr. THOMAS. What is the delivery time on it?

Dr. SILVERSTEIN. The first VEGA is scheduled to come in about the middle of 1960.

Mr. THOMAS. What is the leadtime? Is the leadtime a year, 8 months, or 16 months?

Dr. SILVERSTEIN. 15 months.

Mr. THOMAS. Why buy eight of them at one time?

Dr. SILVERSTEIN. In a program of this type your major cost is the development cost. If we in our purchasing of these vehicles bought three—we know that we have a continuing program which is going to require these big vehicles—and if we bought three and they set up to build only these three, we would get the vehicle just to the point where we would be able to use it adequately, and then have no vehicles for actual experiments. You have to take into account on these new kinds of vehicles the fact that you are not going to make them all successful.

You have to go through a development period and then you are in a position to go ahead and use the vehicle. It depends on the trouble you run into. If you buy only five of them, then you would have to set up production again in order to keep your continuing program into the next year going. On a program such as this, this is a continuing program from year to year and we have to look ahead, and see what is the most economical way we can maintain a continuing program.

We cannot do it by buying just enough vehicles to develop them and then stop, because then we have brought the vehicle to the point of development and we do not have anything to use.

Mr. YATES. At the moment you are buying eight vehicles. Is there not the possibility that in this period there may be improvements which you will want to incorporate into your program and which may make vehicles that you seek in this justification obsolete?

Dr. SILVERSTEIN. Actually, this vehicle is a fairly advanced vehicle. We are not expecting it to be obsolete by the time that we will get it.

Mr. THOMAS. Why do you have to spend $10 million on it? Mr. Rhodes just asked that question of you, but the answer was not clear.

Dr. SILVERSTEIN. Let me go through the steps in this program:

We start with a vehicle which is a very complicated piece of mechanism. You recall that in our missile business we have spent in the past several years billions of dollars to bring these missiles such as the ATLAS, TITAN, and THOR up to a point where they are usable. We are going ahead from the point where they have left us. They have given us a booster and it is very reliable. We have a very definite mission to perform. We are not planning to fly 500 or 5,000 miles, but we are going up to space, and we have to put two new rockets on top of this booster. How do we do it? We want to do it as economically as possible, and where we find a good piece of hardware, we are using a good piece of hardware which was fired 43 times successfully. We are adapting this to the new use of this vehicle.

But when you put something on top of this, another engine has to be developed and a guidance system has to be created for it as well, because we have to have a guidance system for the accuracy we need. Therefore, it takes a third stage engine which needs to be developed using storable propellants. This is a new development. The engine does not exist, and the designs for this third stage have to be worked out.

We are talking about expensive-type developments through a long period of time. They are not done inexpensively.

The cost of the ballistic missile programs is a good example of the kind of cost you get into in developing them.

These numbers we have here are not guesses. They are based on contractual figures.

Mr. THOMAS. What are the elements in the contract, and how many? How many cost accounts and auditors do you have out there at the factory?

Dr. SILVERSTEIN. There is a contract involved here for some $6 million to provide the answers for the VEGA second stage. It is with the GE company. Four million, one hundred and twelve thousand dollars of this is being financed from 1959 funds.

Mr. THOMAS. Is this a cost-plus or fixed-fee contract?

Dr. SILVERSTEIN. It is a cost-plus-fixed-fee.

Mr. THOMAS. Is it a unique item or an item on which you have had some competitive bidding?

Dr. SILVERSTEIN. This is an engine that was originally developed as a result of competitive bidding. We are now using it, after modifying it slightly. There was only one source for this engine, and that was the GE Co.

Mr. THOMAS. There has not been any competitive bidding if there was only one source.

Dr. SILVERSTEIN. In this case there could not be. We cannot get competitive bids for a new engine of this size, because it would be very much more expensive.

As it is, we are essentially modifying an engine that is fairly well along in its development period, and we are modifying it to use it as a second stage.

Mr. THOMAS. They are modifying this particular engine for you and you are the only customer?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. What are the elements of cost which you exclude? What part of the administrative costs do you pay, and so forth?

Do we have any auditors there?

Mr. SIEPERT. With respect to the amount of indirect costs that the Government allows on its contracts of this sort, the auditors compute——

Mr. THOMAS. What is Mr. Siepert's business?

Dr. GLENNAN. He is Director of Business Administration.

Mr. THOMAS. You are an old contract man?

Mr. SIEPERT. No; I would not regard that as my primary speciality.

Mr. THOMAS. Do you not think we need one here, when we are dealing with about $400 million? Do you know something about procurement and the wiles and the ways of business generally?

Mr. SIEPERT. My own experience has included cost-plus contracts in the medical research field.

Mr. THOMAS. I hope we do not have any cost-plus contracts in here.

Mr. SIEPERT. Cost-plus-fixed-fee.

Mr. THOMAS. Let us stay with one or the other.

Mr. SIEPERT. Cost plus a fixed fee is what I am talking about here.

Mr. THOMAS. What are you dealing with here?

Mr. SIEPERT. We are dealing with the cost reimbursement contract which involves a fixed management fee determined prior to the initiation of the work. So it is not a cost-plus contract.

Mr. THOMAS. Have you bought any engines, gears, pumps, and electronics equipment?

Mr. SIEPERT. You ask have I personally?

Mr. THOMAS. Yes.

Mr. SIEPERT. No, sir; I have not.

Mr. THOMAS. Has anyone in the agency?

Mr. SIEPERT. Yes, sir.

Mr. THOMAS. Who?

Mr. SIEPERT. A key appointment which we have made in initiating this program is Mr. Ernest W. Brackett, who transferred from the Air Materiel Command at Wright Field. He is in charge of the contract program.

Mr. THOMAS. Who is he, and where is he?

Mr. SIEPERT. Mr. Brackett is located here in Washington.

Mr. THOMAS. What is his grade?

Mr. SIEPERT. He is in an excepted position.

Mr. THOMAS. What was his experience in industry?

Mr. SIEPERT. His experience has been derived in the Government rather than industry.

Mr. THOMAS. In the Government? He is Government trained?

Mr. SIEPERT. Yes, sir; in charge of major procurement on behalf of the Air Force.

Mr. THOMAS. He learns with one hand and gets paid with the other?

Mr. SIEPERT. He is a lawyer by training.

Mr. THOMAS. I thought he was a procurement man.

Mr. SIEPERT. Many of our procurement men have also acquired legal experience because we feel that this is quite essential in the terms of

judgments they have to make on contracts. He was the head of a major military depot during the war, and assigned to the Pentagon afterward in a civilian capacity, and was the chairman of a task force group which established research and development contract procedures for the DOD.

Mr. THOMAS. He is going to spend all this money?

Mr. SIEPERT. He is not alone going to make the decisions with regard to spending it, but, in cooperating with the technical people, will obtain their judgment as to where the contracts will go. I would assure you that our contracts will be good ones.

Mr. THOMAS. Is he over you or under you?

Mr. SIEPERT. I am over him.

Mr. THOMAS. And he is going to spend the money?

Mr. SIEPERT. He will see to it that we have good, tight, legal contracts.

Mr. THOMAS. That is about the way we operate; is it not?

RUSSIAN CAPABILITIES

Mr. YATES. Dr. Silverstein, with respect to your discussion of the VEGA rocket, how does this compare with the ones the Russians use? What did their moon shot consist of? What was the type of vehicle?

Dr. SILVERSTEIN. I do not know exactly. I have never seen it.

Mr. YATES. I wondered whether there had been any reports on it.

Dr. SILVERSTEIN. I do not think there have been any reports that I have seen that are accurate enough to believe.

I think you can make certain decisions based upon the kind of information you get. Their basic booster, I think, is larger than ours. Exactly what its size is I do not know.

I think their vehicle was capable of putting some 790 pounds up near the moon, which is about the capability that the VEGA has. This VEGA will be the first U.S. vehicle to be able to accomplish this mission.

We estimate it is going to take about 15 months to develop it, and I think it is very essential from the standpoint of our whole national position that we do it as rapidly as possible and acquire a vehicle of this capability.

Mr. YATES. I wonder whether it is wiser to effect the development of the second and third stage rockets, or whether to seek a greater thrust on your lower stage rocket; whether this is more economical.

Dr. SILVERSTEIN. You are talking about time here, too. I do not know if you know how long it takes to develop a major booster system, but it would take, instead of some 15 months that we hope to be able to accomplish this vehicle development, a minimum of about 4 years to develop another major booster, and perhaps it would take 5 years. That is how long it takes to develop a new one. You can tell this from the history of the development of the ATLAS. The ATLAS is an old instrument by now, but it is still going through its development phases. It takes a long time to develop a good, sound, reliable missile.

Dr. GLENNAN. The unfortunate part of this business is that you destroy almost everything you test. It is like the film business. If they want to test a piece of film, they must destroy it in order to test it.

In this program we fire these things and if they do not work to the extent that we can understand some of the things that have gone wrong, we do not get the vehicle back.

We have in this budget some small amount of money to study means of recovering these boosters so they may be used a second time. They would stand it. If the ATLAS had fired, and if it had worked perfectly and we could get it back, we could use it again. They do not burn up.

But this is a destructive business, and a terribly expensive business.

Dr. SILVERSTEIN. We went at this job of seeing how at the earliest time and with the greatest engineering judgment we could provide a vehicle that would give us the capability to enable us to hold up our head, and this is the best one we can develop quickly.

Mr. YATES. The VEGA?

Dr. SILVERSTEIN. Yes, sir.

VANGUARD PROGRAM

Mr. THOMAS. Let us now take up the VANGUARD program which appears at pages 245 through 249 of the justifications. We will insert them in the record at this point.

(The pages referred to follow:)

Vanguard Division

Fiscal year 1959	$25,541,282
Fiscal year 1960	----------

1. Objectives

Project VANGUARD was initiated in September of 1955 with the following three objectives:

(1) To place a satellite in orbit around the earth within the time of the International Geophysical Year (July 1957 to December 1958).

(2) To establish means of proving the satellite was in fact in orbit.

(3) To instrument the satellite so that at least one scientific experiment would be accomplished with it.

In order to reach these objectives, it was necessary to—

(1) Design and test a launching vehicle capable of lifting the satellite 300 miles and imparting to it an orbital speed of 5 miles per second.

(2) Develop radio and optical systems to detect the presence of the satellite, determine the characteristics of its flight, record this information, compute the orbital information to predict the orbits, continuously monitor the satellite's orbit to detect changes in precise location and to scientifically analyze and publish the results.

(3) Design the satellite itself, perfect miniature instrumentation capable of picking up the desired scientific information, and provide means of relaying this information to the Minitrack ground stations.

On March 17, 1958, a 3¼-pound test satellite was successfully launched, and is still sending valuable data by radio as it follows an elliptical orbit around the earth. Project VANGUARD has therefore formed a major part of the U.S. contribution to the scientific activities of the International Geophysical Year.

2. History of transfer to the National Aeronautics and Space Administration

The National Aeronautics and Space Act of 1958 (Public Law 85–568) gave the President authority to transfer to the newly established National Aeronautics and Space Administration "any functions * * * of any other department or agency of the United States * * * which relates primarily to the functions, powers, and duties of the Administration as prescribed by section 203 of this Act." Pursuant to this authority, the President issued Executive Order 10783, dated October 1, 1958, which transferred "all functions (including powers, duties, activities, and parts of functions) of the Department of Defense, or of any officer or organizational entity of the Department of Defense with respect to * * * the U.S. scientific satellite project (Project VANGUARD)," to

the National Aeronautics and Space Administration. The Executive order also provided for the transfer of the unexpended balance of appropriations from the Department of Defense to the National Aeronautics and Space Administration.

Under authority of Executive Order 10783, 133 members of the VANGUARD group at the Naval Research Laboratory and 25 persons in other divisions of the Naval Research Laboratory devoting substantially full time to the VANGUARD project, a total of 158 persons, were transferred to NASA on November 30, 1958. Of these 86 are scientists, 42 technicians, and 30 administrative and support personnel.

The unexpended balance of funds available in the Department of Defense appropriation account 97X0112.004, "U.S. scientific satellite," amounting to $25,541,282 on October 31, 1958, was transferred to NASA. On that date the unobligated balance was $12,842,664.

The Secretary of Defense was requested by NASA on September 29, 1958, to continue certain items of logistic support, to continue the assignment of certain military personnel, and to furnish supporting services through the Naval Research Laboratory. Both NASA and the Department of Defense wish to consummate the transfer with minimum interference with the progress of the project. Under an agreement between NASA and DOD, signed November 20, 1958, the VANGUARD staff will remain at its current location at the Naval Research Laboratory until construction of adequate facilities at the NASA Space Projects Center, Beltsville, Md. is completed. The Naval Research Laboratory will provide supporting services to the VANGUARD group on the same basis as such services heretofore have been rendered. It was agreed that the Navy Department will continue to provide contracting officer services for current VANGUARD contracts through completion, but will transfer technical control to NASA. Under the agreement a funding authorization in the form of a "Government order" (HS–23) in the amount of $23,500,000 was issued to the Naval Research Laboratory on November 24, 1958. The remaining $2,041,282 of the transferred VANGUARD funds are being used by NASA for salaries and expenses of the VANGUARD division.

Project VANGUARD developed the IGY radio tracking net (Minitrack) which has been used not only for VANGUARD but for observations of every active satellite so far launched, United States and Russian. With the transfer, responsibility for this network passed to NASA.

3. Program phasing

At the time of transfer to NASA the engineering and manufacture of the vehicles was essentially completed. Seven three-stage vehicles, i. e., test vehicles TV–3, TV–3BU, TV–4, TV–5, and satellite launch vehicles SLV–1, SLV–2, and SLV–3 had been launched. Modifications which resulted from study of records from each launching attempt were being incorporated in the remaining vehicles. Additional preflight operations, intended to eliminate the causes of low performance of the second stage in previous flights, had been adopted and were being applied to SLV–4. Four satellite launching vehicles remained to be fired.

When responsibility for the VANGUARD program was given to NASA, the complete history of the project was reviewed. As a result of its own administrative review, the NASA decided to postpone the next VANGUARD firing from December 1958, to February 1959 for an objective technical review of the vehicle to determine whether any additional steps might be taken to increase the probability of success. A working committee composed largely of electromechanical experts having no previous connection with VANGUARD is studying in detail the systems involved in the sequencing of the upper stages where most of the difficulties appear to be. The committee is examining all pertinent data from the VANGUARD launchings and from the use of VANGUARD components in other vehicles such as the THOR-ABLE reentry and moon-probe vehicles.

It is expected that the remaining VANGUARDS will be fired during the first half of calendar year 1959 with February as the target month for the first firing (SLV–4). This vehicle will carry as planned in the IGY program, the cloud-cover experiment, SLV–5 a magnetometer experiment, SLV–6 heat balance, radio noise, and micrometeorite experiments, and TV–4BU magnetometer, X-ray, and environmental experiments.

After June 30, 1959, as the analysis and publication of research data is completed, VANGUARD Division personnel will be gradually shifted to similar work in other research divisions of the NASA, most of them eventually being expected to form an important part of the staff at the NASA Space Projects Center.

Funding for the VANGUARD Division is not, therefore, carried as an identifiable line entry in the fiscal year 1960; personal services and allied costs are carried as part of the requirements for the Space Projects Center under the salaries and expenses appropriation: contractual services, supplies, equipment, and other support costs are included under appropriate program headings under the research and development appropriation.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
NASA Vanguard Division direct costs:		
Number of employees	200	
Annual cost	$1,493,000	
Less lapses	630,000	
Regular pay	863,000	
Graduate leave	10,000	
Pay above base	5,800	
Overtime pay	217,000	
Other allowances	14,000	
01 Personal services	1,109,800	
02 Travel	350,000	
07 Life insurance	7,500	
11 Retirement	57,000	
15 Taxes	1,000	
Total, NASA Vanguard Division direct costs	1,525,300	
Obligation to the Naval Research Laboratory:		
Payments to cover unliquidated Vanguard obligations and commitments at the time of the transfer and the cost of NRL reimbursable services for the balance of the fiscal year 1959	23,500,000	
Uncommitted balance	515,982	
Total	25,541,282	

Mr. THOMAS. You are out of money, gentlemen.

Dr. DRYDEN. Vanguard, of course, closes at the end of the year. There is no request for a continuation of funds under the Vanguard program.

Mr. THOMAS. This is all transferred money, and your $50 million is already gone.

OBLIGATIONS FOR RESEARCH AND DEVELOPMENT

I have a question written out here as to what your unobligated balance will be. You had $154 million plus that $50 million that they got out of this committee last year.

Mr. ULMER. Mr. Chairman, I personally believe that the unobligated balance will be very small and perhaps zero. We have already obligated about $140 million and have an additional $24 million ready to obligate. That leaves only $40 million.

Mr. THOMAS. So, that is $204 million?

Mr. ULMER. Yes, sir.

Mr. THOMAS. That is all reasearch money, and not salaries and expenses?

Mr. ULMER. All research and development contract funds. There is only about $40 million left to be obligated today.

Mr. THOMAS. What do you mean when you say as of today?

Mr. ULMER. As of today, sir. I got these obligation figures last night.

Mr. THOMAS. You are certain you will not end the year with most of that $44 million.

Mr. ULMER. Most of it will be obligated by the end of the fiscal year.

Mr. THOMAS. Why do you not put on the brakes and look around for a while? You have obligated $200 million and that is a lot of money.

Dr. DRYDEN. We have been given a job to put the country ahead, and I do not know how we can do it without money.

Mr. THOMAS. Doctor, we have heard about putting the country ahead before.

Dr. DRYDEN. This depends upon what the Congress wishes to do.

Mr. THOMAS. I thought we were already ahead except with that little item on the booster. We might be a little short on that.

Dr. GLENNAN. Could I speak to this point?

Mr. THOMAS. Go ahead.

Dr. GLENNAN. This is not a matter of talking big, but rather in response to an atmosphere——

Mr. THOMAS. We all learn by swapping ideas. You have obligated $160 million. You are traveling in a virgin field, and you are not going to set the woods on fire in 1 year.

If you do, you may not get out of the fire.

Dr. GLENNAN. Our assignment is not to set the woods on fire.

Mr. THOMAS. Dr. Dryden said we have to lead the world in this thing. If that is not setting the woods afire, I do not know what you mean.

Mr. BOLAND. He said the Congress said it.

Dr. GLENNAN. You have spoken about estimates, and to an extent some of these things must be estimates, but they are based on the best information we have available. They are based on a lot of past experience and made by good men in my opinion whose engineering judgment oftentimes does not put in enough slack to take care of what we can presently see is going to happen. I think the estimates that back up this budget are pretty tight estimates. Last year we began carrying out a program which the Nation expected to a considerable extent to be carried out as a crash program. We have been doing this and everybody has joined in it including the public, the Congress, the executive branch of the Government, and the armed services, in order to get back as much as possible of the "prestige" that we had lost to the sputnik operation.

In our efforts to get back as much scientific information as we could, a number of results were obtained in that hurry-up process. I think these are results that we ought to, as a Nation, be exceedingly proud of. It will give us a lot of encouragement. If we now lay on a sensible program we can really make progress, but at a sensible pace.

This 1960 budget which you have before you is the first year that we have been able to put together something that begins to approximate a sensible planned program of research and development out of which information should be derived that will allow us to continue this kind of technological activity with increasing success.

Mr. THOMAS. You have a paper program here. It sounds all right on paper. Why do you not try to put a little of it into effect?

Dr. GLENNAN. That is exactly what we are doing and it takes money to do it, and what we are asking for is the kind of money——

Mr. THOMAS. You are trying to put in here about $350 million or $400 million worth the first year.

Dr. GLENNAN. I think if you take into account the costs for the hardware that is necessary just to get the instruments up in the atmosphere or beyond the atmosphere where we need to make the measurements, then the costs that are being expended on the scientific program are not at all out of line. These boosters are the trucks, as someone said, to take the satellite vehicles and the payload packages into outer space from which we can get back the information that we need.

Mr. THOMAS. You are not by yourself in this field.

Dr. GLENNAN. No, sir; we have a country known as Russia that is in this field.

Mr. THOMAS. And you have an Air Force, an Army, and Navy still spending just about as much as you are.

Dr. GLENNAN. That is right.

Mr. THOMAS. They do not call it space, but you can call it any name you want to and they are in the same business.

Dr. GLENNAN. But they are looking toward what they term operational systems which presumably will allow them to do certain military missions better than they can do them with another medium.

Mr. YATES. Will not Dr. Silverstein's vehicle do the same thing?

Dr. GLENNAN. They will use our vehicles, too.

Mr. THOMAS. He may develop it for them.

Dr. SILVERSTEIN. That is the point.

Mr. THOMAS. We are all spending research and development money all over the lot regardless of how this is set up and how that is set up.

Dr. GLENNAN. What I am trying to point out is that I think this is a coordinated program. We are not duplicating expenditures for similar types of vehicles. We are planning rockets suitable for doing the same job, should such tasks have to be done, either by the Air Force or by ourselves.

Mr. THOMAS. You have $44 million unobligated of this $204 million in research and development. Do you plan or do you not plan to obligate it all? As of today you have $44 million unobligated and you have only 60 days left in your fiscal year.

Dr. GLENNAN. If it were just a matter of trying to get the funds obligated in the next 60 days simply, because it is there, then I should say let us not worry about it. But to do this program the way we have to do it, I do not think there is much chance that there will be much of a balance. After all, we have been but 8 months in business, and it is normal that we would not have spent all our money the first month. You have to think, plan, negotiate and design and bring all these things up to a level where I think it is reasonable to expect that the bulk of that will be obligated. Our purpose is not to get such a tremendous push on this thing for the sake of speed alone. It just makes no sense to keep it going that way but, rather, to build sensibly. Just because we happen to be in a business that is very costly——

VANGUARD PROGRAM

Mr. THOMAS. Your justification states as follows:

Project VANGUARD was initiated in September of 1955 with the following three objectives:

(1) To place a satellite in orbit around the earth within the time of the International Geophysical Year, (July 1957 to December 1958).

(2) To establish means of proving the satellite was in fact in orbit.

(3) To instrument the satellite so that at least one scientific experiment would be accomplished with it.

You cannot say too much about your instrumentation because it is through instrumentation that you get your information and you cannot get it all in one shot; can you?

Dr. GLENNAN. No, sir.

Mr. THOMAS. So all you hoped to get was one provable fact in this one shot with your instruments.

Your justification states further:

Design and test a launching vehicle capable of lifting the satellite 300 miles and imparting to it an orbital speed of 5 miles per second.

Develop radio and optical systems to detect the presence of the satellite, determine the characteristics of its flight, record this information, compute the orbital information to predict the orbits, continuously monitor the satellite's orbit to detect changes in precise location and to scientifically analyze and publish the results.

Design the satellite itself, perfect miniature instrumentation capable of picking up the desired scientific information, and provide means of relaying this information to the Minitrack ground stations.

The National Aeronautics and Space Act of 1958 (Public Law 85-568) gave the President authority to transfer to the newly established National Aeronautics and Space Administration any functions of any other department or agency of the United States which relates primarily to the functions, powers, and duties of the Administration as prescribed by section 203 of this act.

Well, he did under authority of Executive Order 10783.

Further quoting from the justifications, I read as follows:

Under authority of Executive Order 10783, 133 members of the VANGUARD group at the Naval Research Laboratory and 25 persons in other divisions of the Naval Research Laboratory devoting substantially full time to the VANGUARD project, a total of 158 persons, were transferred to NASA on November 30, 1958. Of these 86 are scientists, 42 technicians, and 30 administrative and support personnel.

The unexpended balance of funds available in the Department of Defense appropriations account, amounting to $25,541,280 on October 31, 1958, was transferred to NASA. On that date the unobligated balance was $12,842,664.

That is part of that $44 million you have unobligated?

Dr. GLENNAN. It was the amount at the time of the transfer that was unobligated.

Mr. THOMAS. You mean you have already spent it?

Dr. GLENNAN. We have obligated the bulk of it; yes, sir.

Mr. THOMAS. How much do you have left?

Mr. ULMER. We now have $1.4 million unobligated.

Mr. THOMAS. For what was it obligated?

Mr. ULMER. Well, it covers all the contracts in effect at the time we took over the VANGUARD program. It covers the salaries, travel expenses, and other supporting costs for the VANGUARD people.

Mr. THOMAS. The VANGUARD program is over with.

Dr. GLENNAN. No, sir; there are two more shots, and then there will probably be some cleanup work as we put together all the data.

Mr. THOMAS. Is the $25 million going to pay for your instruments and everything?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. And you will come out with a $1 million carryover?

Dr. GLENNAN. No, sir.

Mr. ULMER. I do not think there will be any carryover, Mr. Chairman.

Mr. THOMAS. You mean I was talking too soon?

Mr. OSTERTAG. What happened to all the personnel that you took over?

Mr. THOMAS. What will the overrun be?

Mr. ULMER. They are in the positions that we are requesting for the Beltsville activity next year. They are part of the 1,200 additional people that are in the 1960 budget.

Mr. THOMAS. What will your overrun be in your VANGUARD program?

Mr. ULMER. None, we hope. There will be no overrun, Mr. Thomas.

MINITRACK STATIONS

Mr. THOMAS. (reading):

Project VANGUARD developed the IGY radio tracking net (Minitrack), which has been used not only for VANGUARD, but for observations of every active satellite so far launched, U.S. and Russian. With the transfer, responsibility for this network passed to NASA.

How many such stations were there?

Dr. GLENNAN. I think there were 11.

Mr. THOMAS. Will you insert in the record at this point the location of those stations?

Dr. GLENNAN. I certainly will.

(The information requested follows:)

The following is a list of existing Minitrack Stations: Blossom Point, Md.; Antigua, W.I.F.; San Diego, Calif.; Quito, Ecuador; Lima, Peru; Antofagasta, Chile; Santiago, Chile; Woomera, Australia; Esselen Park, South Africa; Fort Stewart, Ga. (to be moved). (Discontinued—to be shipped to Fort Myers, Fla. in September 1959); Havana, Cuba (to be moved).

Dr. GLENNAN. Mr. Chairman, the last two mentioned there will be moved and built into one station in Florida.

Mr. THOMAS. What did those 11 stations cost you? Do you recall? That is not a part of this $25 million?

Dr. DRYDEN. No, sir; these were in existence under the old program.

Mr. THOMAS. These were built by the IGY?

Dr. DRYDEN. They were in existence when they were turned over to us.

Mr. THOMAS. Does anyone remember what these cost?

It is my recollection that the Navy paid for these.

Dr. DRYDEN. The IGY through the Science Foundation paid for these.

Mr. THOMAS. I do not think so. Did we pay for these?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. You have to have five more tracking stations in addition to these?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. Where are they located?

Dr. GLENNAN. Newfoundland, Alaska, North Central United States, Fort Myers, Fla., and one place in Europe not yet chosen.

Mr. THOMAS. What will be the cost of these five? Do you have an approximate figure there? It is back under your construction item, but I thought I would like to have it here. It is $12 million, as well as I remember.

Dr. GLENNAN. These are a small portion of that.

Dr. DRYDEN. $2,124,000 for four stations.

Mr. OSTERTAG. How many stations will you have all told when you are through?

Dr. DRYDEN. We will have actually 15.

Mr. THOMAS. Let us take a look at your breakdown of this $25.5 million. That was for 1959, and you are not spending anything in 1960.

Your justifications state as follows:

It is expected that the remaining VANGUARDS will be fired during the first half of calendar year 1959 with February as the target month for the first firing.

Have they been fired?

Dr. DRYDEN. Two, sir.

Mr. THOMAS. How many are yet to be fired?

Dr. GLENNAN. Two.

Mr. THOMAS (reading):

This vehicle will carry as planned in the IGY program, the cloud-covering experiment—

and so forth.

Funding for the VANGUARD Division is not, therefore, carried as an identifiable line entry in the fiscal 1960.

Personal services and allied costs are carried as part of the requirements for the Space Project Center under the "Salaries and expenses" appropriation; contractual services, supplies, equipment and other support costs are included under appropriate program headings under the "Research and development" appropriation.

So, there will be an overrun of your $25.5 million?

Mr. ULMER. Not an overrun. The VANGUARD Division becomes integrated as a part of the whole NASA operation.

Mr. THOMAS. That is nice language, but you started out with $25.5 million and you will have to have more money than that. So that is an overrun.

Dr. GLENNAN. These same people are covered under our 1960 budget as part of the Beltsville Space Center, sir.

Mr. THOMAS. Whatever you pay them is over and above the $25.5 million?

Mr. WYATT. But they will be reassigned to other projects than VANGUARD. In other words, they will become part of our total technical employees.

Mr. THOMAS. But you have to have them in order to carry out your other two shots.

Dr. SILVERSTEIN. As expected, these two shots will come off during this fiscal year.

Dr. GLENNAN. Within the next 2 months.

Mr. THOMAS. They will not lap over into 1960?

Dr. GLENNAN. They are not expected to, but they may if we run into technical difficulties.

Mr. YATES. Will you shoot them?

Dr. GLENNAN. Yes, sir.

Mr. OSTERTAG. According to the justifications you have a total of 158 persons being transferred from the VANGUARD group and then you show the NASA and VANGUARD Division direct costs including the number of employees as 200.

Does that mean the new organization will be 200?

Mr. ULMER. All that means, sir, is that on the date of the transfer the actual number of people transferred was 158.

Mr. OSTERTAG. 158?

Mr. ULMER. That is right, sir.

At the time this book was prepared we expected to reach an employment of 200 by the end of the fiscal year. Actually, we are above that at the present time.

Mr. RHODES. Can you tell me why you had to have that computer center down on Pennsylvania Avenue?

Mr. WYATT. Yes, sir; you have to have a single point. With these IGY Minitrack stations around the world, each one of them is getting a fraction of the data as the vehicles passes overhead.

Mr. RHODES. I understand that. Why do you have it in the high-rent district?

Mr. WYATT. It will not be there later. We did not put it there.

Mr. RHODES. I know you did not put it there, but I just wondered about it.

Mr. WYATT. We will probably take it out as soon as our Beltsville Center is created.

Mr. RHODES. It looked to me like a good public relations officer located it there.

Mr. SIEPERT. Sir, there is nothing essential about Pennsylvania Avenue. I expect the International Business Machines had a public relations interest in that site since it is actually their installation. There is, however, an essential thing on the location of such a computer; it must be located in the center of a major communications network. There are very few places in the country that would provide sufficient capacity and Washington happens to be one. Anywhere in the metropolitan area would have satisfied that requirement.

Mr. RHODES. Where is it carried?

Mr. SIEPERT. Under contractual services, Research and Development.

Mr. THOMAS. Gentlemen, that will be all today.

We will resume in the morning at 10 o'clock.

FRIDAY, MAY 1, 1959.

Mr. THOMAS. Gentlemen, will the committee please come to order?

SATELLITE APPLICATIONS INVESTIGATIONS

METEOROLOGY PROGRAM

Gentlemen, let us take a look at your request in the field of meteorology.

At this point in the record we will insert pages 250, 251, and 252 of the justifications.

(The pages follow:)

METEOROLOGY

Fiscal year 1959 ..... $2,500,000
Fiscal year 1960 10,800,000

1. Objectives

To establish a meteorological satellite capability which would make possible within the next decade a fully operational system having worldwide coverage. To develop for this system stabilized satellites for polar orbits of 500 to 1,000 mile altitude and "stationary" satellites for equatorial orbits of 22,000 mile altitude. To develop suitable radiation detection equipment, including television, infrared detectors, and radar to measure such things as cloud cover, storm location, precipitation, temperature, wind direction, heat balance, and water vapor. To develop data transmission techniques for continuously feeding information into a national weather center managed by the U.S. Weather Bureau. The large amounts of data will probably require satellite to satellite transmission and special computing machine techniques on the ground. A worldwide tracking and telemetering network will be required.

2. Justification

The earth satellite represents a new observational tool which promises to be of great value to the science and the practice of meteorology. Although it would be a mistake to imply that such a device will eliminate our meteorological limitations, there is no doubt that it will supply a tremendous amount of useful meteorological data not now obtainable. It will do this not only because of its ability to give worldwide coverage of some meteorological parameters, in contrast to the current 5 to 10 percent coverage, but also because of its unique vantage point above the atmosphere which will make new measurements possible. Improvements in basic scientific understanding, climatology, forecasting, and weather control techniques should result.

The benefits to be derived from improved capacity in meteorology include convenience in planning personal activities, protection of life and property from weather disasters; safeguarding transportation; crop planning, control, and protection; industrial planning of weather-dependent products, outdoor enterprises, and heating and cooling loads; eventual limited weather control; and good will in return for providing these services to less fortunate people. In addition, the same meteorological data required for worldwide civilian needs can, by proper handling, be made to meet special military needs as well.

3. Program phasing

Items to be purchased with the fiscal year 1959 funds which will initiate the program include (a) radiation detection equipment and associated ground equipment for a meteorological satellite (TIROS) to be launched before the end of 1959 and in the spring of 1960; (b) tracking, telemetering, data processing, and data analysis equipment and services for these satellites; and (c) development of equipment for a series of stabilized follow-on meteorological satellites.

The fiscal year 1960 funds are designed to carry on this program at an accelerated rate. Some funds will be required for operational services related to the second TIROS launch. The majority of the funds will be required to complete item (c) preparatory to two launchings in 1961.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Research and development on advanced instrumentation	$1,100,000	$1,000,000
Systems studies	150,000	200,000
Prototypes and operational hardware: Meteorological satellite development and procurement	850,000	6,300,000
Operations and technical services: Data acquisition, reduction, and analysis	200,000	2,500,000
Supplies, equipment, repairs, and alterations	200,000	800,000
Total	2,500,000	10,800,000

Mr. THOMAS. I note that you go from $2.5 million in fiscal year 1959 up to $10.8 million in fiscal year 1960.

This is an item in research and development, and your justifications state as follows:

To establish a meterorological satellite capability which would make possible within the next decade a fully operational system having worldwide coverage. To develop for this system stabilized satellites for polar orbits of 500 to 1,000 mile altitude and "stationary" satellites for equatorial orbits of 22,000 mile altitude.

The earth satellite represents a new observational tool which promises to be of great value to the science and the practice of meteorology.

This is where we are going to have these stationary platforms?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS (reading further):

Items to be purchased with the fiscal year 1959 funds which will initiate the program include (*a*) radiation detection equipment and associated ground equipment for a meteorological satellite (TIROS) to be launched before the end of 1959 and in the spring of 1960; (*b*) tracking, telemetering, data processing, and data analysis equipment and services for these satellites; and (*c*) development of equipment for a series of stabilized follow-on meteorological satellites.

For meteorological satellite development and procurement you have $850,000 in fiscal year 1959 as against the request for 1960 in the amount of $6.3 million.

How much have you obligated on this program to date out of your $2.5 million?

Mr. ULMER. $700,000, Mr. Thomas.

Mr. THOMAS. Where is the work being done, and by whom? Is it being done in your own shop?

Mr. ULMER. We have a $150,000 contract with the U.S. Weather Bureau for meteorological analysis and a $540,000 contract with the Army Signal Corps in connection with Project TIROS.

Mr. THOMAS. What service is the Army Signal Corps going to perform?

Dr. SILVERSTEIN. They are working on the satellite payload itself for TIROS. I think we showed you a chart in our broad presentation in this area which showed the satellite and some of the equipment in it.

Mr. THOMAS. With what type plant will the satellite be put into orbit?

Dr. SILVERSTEIN. This will use the THOR-ABLE configuration. THOR is the first stage and VANGUARD the second, and the ABLE is the third stage.

Mr. THOMAS. How did you arrive at this figure for data acquisition, reduction, and analysis in the amount of $2.5 million, and the figure of $800,000 for supplies, equipment, repairs, and alterations? How much of this is a guesswork figure?

Dr. SILVERSTEIN. These numbers are estimates but fairly sound estimates based on the figures of the Weather Bureau which is doing part of this data acquisition and reduction. The Signal Corps, who will do a part of it——

Mr. THOMAS. How is this going to fit in with Dr. Revell's operations? Dr. Revell told us we were going to learn as much about the weather from the bottom of the ocean as we will learn up 22,000 miles about the earth.

Dr. SILVERSTEIN. I think we are going to learn about the weather from all information we can get.

Mr. THOMAS. That is right. He says it is going to take both to give us complete and permanent answers.

You will have to do a whole lot of staying over the two poles on the ground and up in the air also?

Dr. SILVERSTEIN. I would agree with him on that, sir.

Mr. THOMAS. How many shots are you going to make with this $10.8 million?

Dr. SILVERSTEIN. The $10.8 million takes care of the two TIROS firings and will initiate the work on the advanced payload for the next satellite that will come along with a VEGA vehicle.

Mr. THOMAS. In other words, this represents two TIROS?

Dr. SILVERSTEIN. Yes, sir. Two TIROS shots; one late this year and one the middle of next year, and then we will start the advanced payload for the following shot which will be made with a VEGA vehicle as a booster.

Mr. THOMAS. How did you arrive at that figure of $550,000 which you are paying to the Army Signal Corps?

Dr. SILVERSTEIN. Our contract is for $540,000, sir.

Mr. THOMAS. What are they making for you?

Dr. SILVERSTEIN. The infrared package that goes in the satellite. This is a gadget by which we determine the amount of radiation from the different ground——

Mr. THOMAS. Are they the only ones working on your package in this field?

Dr. SILVERSTEIN. They are working on this part of the package.

Mr. THOMAS. What is your entire instrumentation in the satellite going to cost you?

Dr. SILVERSTEIN. I think the whole satellite will cost in the neighborhood of $3.5 million, but part of this is being funded from the ARPA fund because they initiated this TIROS program, and we are supporting it. It is being transferred to our jurisdiction on the first of the fiscal year.

Mr. THOMAS. These are 1960 funds? The $10.8 million is not transferred funds, but newly appropirated funds?

Dr. SILVERSTEIN. Yes, sir. The point I am making is that the TIROS projects were initiated and funded out of 1959 funds and the continuing support for the TIROS program during the firings and data acquisition will be paid for with NASA 1960 funds.

COMMUNICATIONS

Mr. THOMAS. At this point in the record we shall insert pages 253 through 255 of the justifications into the record.

(The pages follow:)

COMMUNICATIONS

Fiscal year 1959	$3,460,000
Fiscal year 1960	4,700,000

1. Objectives

To develop communication satellites and operating techniques suitable for use in a worldwide communications system; such satellites would be intended as relay stations for ground-to-ground, ground-to-satellite, and satellite-to-ground transmissions of messages, data, voice, and television.

To conduct research and development in the following areas in support of this program: (*a*) passive relays which reflect radio waves omnidirectionally, as with a sphere, or directionally, as with a corner reflector which must be

aimed; (*b*) active relays which repeat messages immediately or at some delayed time; (*c*) high-power directional antennas for ground and satellite installation; (*d*) sensitive "low noise" receivers; (*e*) stabilizing and aiming devices; (*f*) lightweight power supplies; (*g*) "stationary" satellites in equatorial orbit; (*h*) propagation of electromagnetic radiation; and (*i*) world communication needs studies.

2. Justification

Long-range communications in the form of telephone, telegraph, and television networks are now accomplished by means of land lines, cables, long and short wave radio, and microwave relay stations. The total band width of land lines, cables, and low-frequency radio is limited. Short wave radio bands are crowded and are unreliable because of atmosphere interference and ionospheric irregularity. Ultrashortwave and microwave radio is usually limited to line-of-sight range; long distance communications at these frequencies is commonly achieved by means of repeater stations.

Satellites offer the possibility of worldwide communications by ultrashortwave or microwave radio because the line-of-sight range at satellite altitudes is very large. The band width or channel capabilities at these wavelengths is sufficient for television and most other foreseeable communications needs.

3. Program phasing

In the fiscal year 1959, NASA efforts on communication satellites are being directed toward preliminary experiments with a spherical reflector satellite. A 100-foot diameter sphere will be placed in orbit in the winter of 1959 and various experiments on tracking and on propagation of radio waves will be conducted. In addition, studies of more sophisticated satellites, world communications needs, and the accompanying ground equipment are being initiated. In 1960 and 1961, three additional large spheres will be launched as well as on repeater-type communications satellite.

The major item of expense in the fiscal year 1959 is completion of the first 100-foot sphere experiment. The program will be expanded during the fiscal year 1960 to include the additional sphere experiments as well as development of an active repeater payload suited to commercial television and data relay needs. Support for development of stabilization systems and a 22,000-mile orbit capability is included.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Satellite stabilization		$200,000
Repeater satellite		700,000
Passive reflector	$160,000	200,000
System and long-range needs		200,000
Ground support		200,000
Prototypes and operational hardware: Payloads	3,150,000	1,100,000
Operations and technical services: Data acquisition, reduction, and analysis	100,000	1,500,000
Supplies, equipment, repairs, and alterations	50,000	600,000
Total	3,460,000	4,700,000

Mr. THOMAS. You are requesting in the field of communications in fiscal year 1960 $4.7 million as against $3.46 million in fiscal year 1959?

Dr. GLENNAN. May I interrupt to point out that in this meteorological field what we are doing here is really the start on a program which is going to cost a considerable amount of money over the next several years, perhaps the next decade, but if successful it probably will repay much more annually than the total cost of the entire space program which NASA is undertaking.

This whole business of understanding the weather better, whether it be——

Mr. THOMAS. It is at least something that you can put your teeth in.

Dr. GLENNAN. Yes, sir. It touches all of this, and it touches all of our practical applications.

Mr. THOMAS. It is the most practical phase of the entire program.

Dr. GLENNAN. This program and the communications program are the ones of great application.

Mr. THOMAS. Certainly, we ought to bear down on the weather sections and your communications sections because if there are two practical aspects of it which everyone can see, it is those two right there.

Now, let us take a look at your "Communications."

FUTURE ADDITIONAL NEEDS

What will be your offhand guess as to your future needs in addition to this $10.8 million for the program on meteorology? You said it would be one of the big programs.

Dr. SILVERSTEIN. I think this program will grow in size in the years ahead.

Mr. THOMAS. You have two shots scheduled for this year?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. How many do you think you will average a year, and for how many years?

Dr. SILVERSTEIN. I think we will average at least one major shot with a large stabilized satellite per year for the next year or two and then, possibly, as we get closer to our systems, we will have more; perhaps two or three.

Mr. THOMAS. It looks to me as if you are in a field where it is very difficult to guess. The more information you get, the more satellites you are going to have to send up.

Dr. GLENNAN. There is something about that which rings true.

Mr. JONAS. Are you going to put the TIROS satellite in a polar orbit?

Dr. SILVERSTEIN. TIROS will not be in a polar orbit, It will have a high-angle orbit aimed northeast at a 51-degree arc.

STATUS OF FIRST SATELLITE

Mr. JONAS. What happened to the first satellite that went into a polar orbit? The communications system was faulty; was it not?

Dr. SILVERSTEIN. Apparently. This seemed to be the difficulty. The antennas were not properly alined so the ground stations could pick up the signals.

Mr. JONAS. It did go into orbit; did it not?

Dr. SILVERSTEIN. There was every indication that it did.

Mr. JONAS. Is it, by and large, more difficult to sustain an orbit around the poles than it is at the equator?

Dr. SILVERSTEIN. It is a little more difficult to set up the orbit. It takes a little more energy because you do not have the velocity of the earth to start you off. It takes another equivalent of, say, 1,000 feet a second.

Mr. JONAS. Your VEGA vehicle will overcome that very nicely; will it not?

Dr. SILVERSTEIN. Our VEGA vehicle will be large enough to take care of it; yes, sir.

COMMUNICATION RELAY PLATFORMS

Mr. THOMAS. Your justifications state as follows:

To develop communications satellites and operating techniques suitable for use in a worldwide communications system; such satellites would be intended as relay stations for ground-to-ground, ground-to-satellite, and satellite-to-ground transmissions of messages, data, voice and television.

These are your platforms where you are going to have one above the other and you are going to have one away up there to relay down and another one will relay back to the ground? Is that the pattern?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. Reading further:

To conduct research and development in the following areas in support of this program.

Long-range communications in the form of telephone, telegraph, and television networks are now accomplished by means of land lines, cables, long and short wave radio, and microwave relay stations. The total band width of land lines, cables, and low-frequency radio is limited.

Satellites offer the possibility of worldwide communications by ultra-short wave or microwave radio because the line-of-sight range at satellite altitudes is very large. The band width or channel capabilities at these wave lengths is sufficient for television and most other foreseeable communication needs.

What is the life of one of these satellites when you once get it in orbit?

SPHERICAL REFLECTOR SATELLITE

In the fiscal year 1959, NASA efforts on communications satellites are being directed toward preliminary experiments with a spherical reflector satellite. A 100-foot-diameter sphere will be placed in orbit in the winter of 1959 and various experiments on tracking and on propagation of radio waves will be conducted. In addition, studies of more sophisticated satellites, world communications needs, and the accompanying ground equipment are being initiated.

This 100-foot diameter sphere is a rather large one; it is not?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. It is a little bit larger than the one we put in orbit not long ago. How much will it weigh?

You have one for 1959 and will have three in 1960 and 1961? Is that the program?

Dr. SILVERSTEIN. That is right, sir.

Mr. THOMAS. With what will it be placed in orbit? What powerplant will you use?

Dr. SILVERSTEIN. This is going to be done with one of our Delta vehicles that we described to you.

Mr. THOMAS. What will this 100-foot-diameter sphere weigh?

Dr. SILVERSTEIN. About 160 pounds.

Mr. THOMAS. About 160 pounds?

Dr. SILVERSTEIN. Yes, sir. It is made out of .0005 inch thick mylar.

Mr. THOMAS. You do not have very heavy instruments in it; do you?

Dr. SILVERSTEIN. There is no instrumentation aboard. You see, the thing is passive. It is a big reflector and you fire radio waves from the ground at it and they are reflected from it back to another station.

Mr. THOMAS. And that is the reason for the great size of it?

Dr. SILVERSTEIN. The great size gives you a big reflecting surface.

Mr. THOMAS. Is this going to be stationary or moving?

Mr. SILVERSTEIN. The first ones will be moving.

Mr. THOMAS. At what altitude will they be stationed?

Mr. SILVERSTEIN. 600 miles.

Mr. THOMAS. This is really a new start and a new effort? Has it been tried before?

Mr. SILVERSTEIN. Never. It is a major technical development.

EXPENDITURES AND OBLIGATIONS

Mr. THOMAS. Where is this $3.46 million? How much of that have you spent this year and for what did you spend it?

Mr. SILVERSTEIN. The $3.46 million?

Mr. THOMAS. Yes. I note that $3.15 million was for payloads.

Mr. ULMER. We have obligated a total of 2.15 million on this program, Mr. Thomas.

Mr. THOMAS. Are you through with your obligations?

Mr. ULMER. No, sir.

Mr. THOMAS. For what items did you obligate it? You have a figure set up for payloads. What would be in there if it is going to be a reflecting job, and you have no instruments? What do you need that much money for?

Dr. SILVERSTEIN. There is quite a development job on these payloads, Mr. Chairman.

Mr. THOMAS. You mean for the development of the plastic sphere itself?

DESCRIPTION OF SPHERICAL REFLECTOR SATELLITE

Dr. SILVERSTEIN. Yes, sir. You see, this thing is a fairly fantastic piece of equipment. Actually, you have a sphere 100 feet in diameter which has to be constructed in such a fashion that it can be placed in a 30-inch diameter case. You have to be able to inflate it. You have to arrange the seams in this 0.0005 inch thickness of plastic so they will hold when you put it into space; it has to be inflated to its full dimensions and stay in a spherical shape.

Dr. GLENNAN. I think the fascinating part of this is the means used for inflating it where you just use water which vaporizes.

Dr. SILVERSTEIN. You see, it will have a little bit of air left in it. In packing it, you press out most of the air and when you go up to these very high altitudes where the pressure is very low, this air expands. Then we put some water in it. Because the pressure is very low, the water will vaporize and that fills it out the rest of the way.

The development of this payload requires that we figure out how to package it so that when we release it from the case it performs properly.

Mr. THOMAS. Who is working this out for you? Where are you spending this money? Is this being done in your own laboratory or where?

Dr. SILVERSTEIN. Largely, the development of this payload has been in our own laboratories.

Mr. THOMAS. Where?

Dr. SILVERSTEIN. At the NASA Langley Research Center.

CONTRACTS

Mr. THOMAS. Do you have any outside contracts?

Dr. SILVERSTEIN. We have outside contracts; yes. We have to develop ground equipment for this payload. In other words, you have to have radio equipment on the ground that will fire radio waves at the reflector and receive them at the other end, and we have contracts that are aimed at the development of this ground equipment.

Dr. GLENNAN. The Army Ballistic Missile Agency is doing this.

Mr. THOMAS. You have to have your payload itself which is special equipment, and your firing apparatus is also special equipment as well as your radio?

Dr. SILVERSTEIN. Yes, sir.

SPACE OPERATIONS TECHNOLOGY

MANNED SPACE FLIGHT

Mr. THOMAS. Gentlemen, we shall now take a look at your supplemental request, and at this point in the record we shall insert pages 256 through 259 of the justifications.

(The pages follow:)

MANNED SPACE FLIGHT

Fiscal year 1959	$37,661,200
Fiscal year 1959 supplemental	20,750,000
Fiscal year 1960	70,000,000

1. Objectives

To provide a capability for accomplishing advanced space flight missions with vehicles where on-board human intelligence and operations are required. It will be a basic objective of the NASA to rationalize and refine the technology of manned space flight vehicles and associated systems, to achieve successful orbital flight and recovery of a manned satellite with an ICBM-booster and drag-reentry system, to evaluate the physiological and psychological effects of a space environment on man, to establish his capabilities and limitations for performing useful missions in space, and to devise and develop improved manned vehicles with increased capabilities for performing important advanced missions.

2. Justification

It is becoming increasingly evident that full exploitation of the potentialities of space flight for benefiting mankind will be dependent on the development of practical capabilities for operating manned space vehicles. While it may appear in principle that suitable instrumentation may be devised to perform increasingly complex space missions, in practice the availability in a vehicle of human intelligence and operational capabilities will prove to be the most effective method for successful accomplishment of many advanced space flight missions. In particular, he can contribute to the tasks of space exploration and utilization an observational, analytical, and decision-making ability concerning both expected and unanticipated problems, and a vast flexibility of action for operation, correction, and maintenance of scientific and technological instrumentation and equipment that characterize his present usefulness in airplanes and the scientific laboratory.

In order to provide this capability a progressive program of research and development has been undertaken. A broad range of investigations directed to the solution of basic technological problems concerning vehicular configurations and construction, human factors, life support equipment and accommodations, launching systems, stabilization and control, reentry and recovery systems and techniques, operational and scientific instrumentation, and other vehicular subsystems has been initiated.

On the basis of extensive studies it has become evident that the first manned orbiting flight vehicle should be based on the use of an ICBM-booster launching system and the ballistic type of drag reentry into the atmosphere. The relative simplicity and reliability of this approach at the present state of the art offers the best potentiality for early success and will yield a vehicle with a wide range of usefulness for investigating problems concerning both human and vehicular operation factors. This vehicle is also a logical stepping stone to larger systems of the same type with greater capacity for performing both scientific, civil and military services. In addition, it is adaptable to the investigation of both reaction-type space-path control and aerodynamic-lifting systems that will give later manned space vehicles a greatly increased scope of operations.

3. Program phasing

During the fiscal year 1959, a wide range of studies and experimental investigations is being initiated to assess the problems that will be encountered in initial development and operation of manned space flight vehicles and to establish the design requirements for the first operational vehicle. A contract for the design and construction of the full-scale manned capsule and associated instrumentation and equipment shoud be let early in 1959 and the initial capsule for preliminary investigations should become available approximately 9 months later.

Booster systems including solid-rocket clusters and liquid systems up to the ICBM size are being procured to provide for a progressive series of unmanned flights at increasing velocities up to orbital speed to refine both the vehicular systems and operational techniques to insure the safety of later manned operations.

Some of these preliminary flights will also utilize lower primates to assess a range of physiological and psychological factors that will be attendant to manned operation. Concurrently an intensive program of pilot training involving centrifuge, pressure chamber, simulator and balloon experiments will be undertaken.

Further extensions of these programs are planned for the fiscal year 1960. During this period it is expected that the first orbital flights of the unmanned full-scale capsules will be achieved and effective techniques developed for the reentry and recovery phases of the operation. If the systems and techniques prove successful, some preliminary flights at suborbital speeds with the manned capsule may be undertaken. Additional vehicle capsules and boosters and associated equipment will be procured for the continuing manned flight experiments in the following year.

During the fiscal year 1960 it is also planned to undertake the development and construction of more refined versions of the vehicle that will offer greater capabilities for performing scientific investigations in space and for providing space path control. A range of analytical studies and model experiments will be undertaken to define the optimum approach to these problems and establish the basic design requirements. Initial development of appropriate vehicles should be undertaken.

The major items to be procured for this project are the satellite capsules. A total of 12 capsules will be delivered during the fiscal year 1960; fiscal year 1959 funds will be used for the design, engineering and early construction phases of these satellites. Boosters for short range test and qualification flights will also be purchased during the fiscal year 1959 and funds will be committed for the ICBM-boosters required for the first orbital flights. The boosters for the manned orbital flights will be purchased in the fiscal year 1960.

4. Program costs

	Fiscal year 1959	Fiscal year 1959 supplemental	Fiscal year 1960
Scientific and technical studies:			
Human factors	$600,000		
Range and recovery	100,000		$300,000
Design studies of advanced systems			1,000,000
Prototypes and operational hardware:			
Capsules	11,500,000	$4,000,000	22,000,000
Boosters	21,861,200	16,000,000	27,700,000
Operations and technical services:			
Flight test operations	1,100,000		9,500,000
Range and recovery	600,000		3,000,000
Pilot training			500,000
Supplies, equipment, repairs, and alterations:			
Large scale and wind tunnel models	400,000		3,400,000
Environmental and functional test equipment for capsules and components	500,000		1,000,000
Data acquisition and handling equipment	300,000	200,000	300,000
Simulators and personnel equipment for human factor research and personnel training	150,000	500,000	500,000
All other items	550,000	50,000	800,000
Total	37,661,200	20,750,000	70,000,000

Mr. THOMAS. You have a supplemental request for fiscal year 1959 in the amount of $20,750,000, and your request for fiscal year 1960 is in the amount of $70 million.

Your regular fiscal year 1959 appropriation was in the amount of $37,661,200.

This is for your manned space flight program.

Your justifications state as follows:

To provide a capability for accomplishing advanced space flight missions with vehicles where on-board human intelligence and operations are required. It will be a basic objective of the NASA to rationalize and refine the technology of manned space flight vehicles and associated systems, to achieve successful orbital flight and recovery of a manned satellite with an ICBM-booster and drag-reentry system, to evaluate the physiological and psychological effects of a space environment on man, to establish his capabilities and limitations for performing useful missions in space, and to devise and develop improved manned vehicles with increased capabilities for performing important advanced missions.

It is becoming increasingly evident that full exploitation of the potentialities of space flight for benefiting mankind will be dependent on the development of practical capabilities for operating manned space vehicles. While it may appear in principle that suitable instrumentation may be devised to perform increasingly complex space missions, in practice the availability in a vehicle of human intelligence and operational capabilities will prove to be the most effective method for successful accomplishment of many advanced space flight missions.

What are you going to gain, and what is the purpose of this? What do you hope to obtain? That is the $64 question.

Suppose we are asked that question. What is going to be our answer in justification of the amount which you have spent this year, the supplemental, and what you want to spend next year?

I believe the total program costs for the 2 years is about $130 million.

Dr. GLENNAN. I think that there is no question but that we have not as yet devised any piece of instrumentation that can compare with man; certainly, for many of the measurements we will make we can rely upon, remotely controlled and remotely understood——

Mr. THOMAS. Doctor, no one is going to disagree with you on that basis.

What is that man going to do when he gets up there and what is he going to learn?

Dr. GLENNAN. He is going to be able better to interpret what he finds up there.

Mr. THOMAS. What will he see?

Dr. GLENNAN. He will not see very much, but he will be better able to interpret it. If an emergency occurs or if he wants, for instance, to direct the apparatus which we are using for scanning a portion of the atmosphere in another direction because he has found something interesting and he wants to really have a more detailed look at it, this he can do.

We do not know how to make instruments that will do this very well. I doubt that we have any instrumentation that will do this.

Mr. THOMAS. Off the record.

(Discussion off the record.)

Mr. THOMAS. Gentlemen, let me read two or three more choice sentences here:

During the fiscal year 1959, a wide range of studies and experimental investigations is being initiated to assess the problems that will be encountered in initial development and operation of manned space flight vehicles and to establish the design requirements for the first operational vehicle.

Reading further:

During the fiscal year 1960 it is also planned to undertake the development and construction of more refined versions of the vehicle that will offer greater capabilities for performing scientific investigations in space and for providing space path control.

Further extensions of these programs are planned for the fiscal year 1960. During this period it is expected the first orbital flights of the unmanned full-scale capsules will be achieved and effective techniques developed for the reentry and recovery phase of the operation.

What is a good guess as to when you will be ready?

Dr. GLENNAN. We have laid on 25 test flights between now and the end of 1960 and we have the orbital flight beyond that.

CAPSULE CONTRACT

Mr. THOMAS. What are the major items to be procured for this project?

Dr. GLENNAN. The satellite capsules and boosters.

Mr. THOMAS. Capsules? I note you state—

A total of 12 capsules will be delivered during the fiscal year 1960; fiscal year 1959 funds will be used for the design, engineering, and early construction phases of these satellites. Boosters for short-range tests and qualification flights will also be purchased during the year 1959 and funds will be committed for the ICBM-boosters required for the first orbital flights. The boosters for the manned orbital flights will be purchased in the fiscal year 1960.

What type powerplant are we going to use on this one?

Dr. GLENNAN. That will be the ICBM, the ATLAS.

Mr. THOMAS. How high do we intend to go?

Dr. SILVERSTEIN. About 120 miles.

Mr. THOMAS. That is still pretty high; is it not?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. Who is developing the capsule for you? Is that firm in St. Louis?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. What are you paying for that?

Dr. SILVERSTEIN. The capsule contract was around $19 million or $20 million.

Mr. THOMAS. Is that for engineering and development work, or is that for a turnkey job?

Dr. SILVERSTEIN. That is a turnkey job basically for 12 capsules.

Mr. THOMAS. What are the other big items of expense?

Dr. SILVERSTEIN. The boosters are shown here as a major item of expense.

Mr. THOMAS. You have for "human factors" $600,000 in 1959 and there is blank space for that item in 1960.

What do you mean by "human factors" in the amount of $600,000 in 1959, and nothing in 1960?

You have not solved this human factor; have you?

Dr. SILVERSTEIN. No, sir. There will be work going on in human factors that will have been started in 1959 under contract and will continue in 1960.

Mr. OSTERTAG. You mean the money you had in 1959 will take you through 1960 in this particular area?

Mr. THOMAS. For "Design studies of advanced systems" you are requesting $1 million.

What does that mean? What is this for? You said the cost of your capsule contract was $20 million.

Dr. SILVERSTEIN. To be exact, sir, it is $19.45 million.

Mr. THOMAS. Per copy? Each one?

Dr. SILVERSTEIN. No, sir. These will be 12 turnkey capsules.

Mr. THOMAS. That is for your 12 capsules including your prototype research and development and everything else for the 12 capsules?

Dr. SILVERSTEIN. Yes, sir. There will be a few initial capsules that we will use before we get these capsules from McDonald. They will be used in some of the earlier flights.

BOOSTERS

Mr. THOMAS. You have "prototype and operational hardware."

What do you mean by that?

Do you mean capsules and boosters?

Is that a firm contract? You have boosters listed in the amount of $27.7 million.

Dr. SILVERSTEIN. The boosters are firm. We, as you know, have to purchase our boosters from the military and we are using some 25 boosters in this program.

Mr. THOMAS. Who makes these for the military? Did you say this was an ATLAS?

Dr. SILVERSTEIN. The final booster is the ATLAS, but before we get to the ATLAS we go through a series of flights with the REDSTONE.

Mr. THOMAS. And, you have a cluster of four different powerplants?

Dr. SILVERSTEIN. Yes, sir.

LAUNCHING COSTS

Mr. THOMAS. How did you arrive at the figure of $27.7 million? What does it cover? Are there any salaries and expenses involved in this item?

Dr. SILVERSTEIN. None of ours, sir. It covers a fairly firm price that can be given us by the military for the purchase of these articles; the price includes the launching costs.

Mr. THOMAS. Who launches it for you?

Dr. SILVERSTEIN. Well, they will be launched, for example, in this way: When we fire an ATLAS it will be launched under the general guidance of BMD but by the Convair organization at Canaveral.

Mr. THOMAS. Or on the Pacific coast?

Dr. SILVERSTEIN. This will all be at Canaveral.

Mr. THOMAS. I note that for flight test operations you are requesting $9.5 million; for range and recovery you are requesting $3 million and for pilot training you are requesting $500,000.

What do you mean by "flight test operations" in the amount of $9.5 million?

Dr. SILVERSTEIN. You see, in doing this job we are going to have to set up a very complete group of people at many places around the world.

Mr. THOMAS. You testified you were going to have about 12 tests before you made the final effort?

Dr. SILVERSTEIN. We will have more than that. We see on this chart here some 25 firings and these will have to be covered as a part of the flight test.

Mr. THOMAS. What is going up? Is there any instrumentation in each one of your firings?

Dr. SILVERSTEIN. Oh, very complete instrumentation in all the firings.

Mr. THOMAS. Will a human being be inside the capsule?

Dr. SILVERSTEIN. No, sir; not for all the firings. They will be in these REDSTONE firings. We start off by first firing a capsule without anything aboard except the instrumentation and we will send back all the information regarding the temperatures in the capsule, the structural stresses on it, the stabilization and how it stabilizes in flight. Then we will have an animal flying next.

We will put aboard an animal and then we will measure the characteristics of the animal during the flight time.

When we have developed the capsule and the instrumentation, then in these REDSTONE flights—in about the No. 3 or 4 flight—we will put a man aboard.

Mr. THOMAS. How high will he go?

Dr. SILVERSTEIN. About 100 miles high in the initial flight.

Mr. OSTERTAG. You can control the distance?

Dr. SILVERSTEIN. Yes, sir, by the amount of thrust we put in the rocket.

SUPPLIES, EQUIPMENT, REPAIRS, AND ALTERATIONS

Mr. THOMAS. Under Supplies, equipment, repairs, and alterations you are requesting for large scale and wind tunnel models $3.4 million; environmental and functional test equipment for capsules and components, $1 million; data acquisition and handling equipment, $300,000; simulators and personnel equipment for human factor research and personnel training, $500,000; and then you have a coverall item of $800,000.

These are nice, fat, round figures.

Frankly, I do not think you can give us within 50 percent what this is going to cost you. Perhaps you have covered it the best you can.

Dr. SILVERSTEIN. Mr. Chairman——

Mr. THOMAS. Is that a fair statement?

Dr. SILVERSTEIN. No; I do not think so.

Mr. THOMAS. How much guesswork is involved here?

Dr. SILVERSTEIN. This is an estimate, as you must understand.

Mr. THOMAS. And if you can come within 20 percent or 25 percent of it you are pretty good. You are not only good, but excellent.

Dr. SILVERSTEIN. A large part of this is in the booster cost, and we do have firm figures on that.

Mr. THOMAS. The sum of $27.7 million is not more than one-third of this whole amount.

Dr. GLENNAN. Your capsule is added onto that in the amount of $22 million.

Dr. SILVERSTEIN. I think we have probably estimated this within 10 percent. I cannot claim any greater accuracy than that. I think the estimate might be low rather than high.

Mr. THOMAS. If you can come within 10 percent, you are not good, but perfect.

Mr. JONAS. I heard over the radio last night that Congressman Overton Brooks announced in a speech yesterday that we are getting ready to send four white mice up in the next couple of days.

Is that a part of this particular buildup?

Dr. GLENNAN. No, sir; that is a part of a program being carried out by ARPA which is called the DISCOVERER program. What they find out in that program about the reaction of the mice to flight will be fed back into our program. In all flights of this kind where there are bits of information that are picked up that will be useful in our program it comes back to us.

This is done through a cross index or cross membership on a variety of committees that worry about these things. That is a Polar orbit you have heard about of the DISCOVERER which was fired very recently.

Mr. OSTERTAG. Then this project that you speak of is associated with the military; is it not?

Dr. GLENNAN. Ultimately the military are going to want to put men in space. I do not think there is any question about that, but the DISCOVERER projects has a variety of end results which they are aiming at.

They have some spare space in the payload package and they just put in a few of the mice in the instrument. The mice are going along

for the ride, as it were. There is no use wasting the space. There is no use wasting that weight. We want to find out as much as we can as it brings down the cost of the operation in the long run.

Mr. RHODES. I am curious as to one other thing:

Why are you putting a man into a ballistic flight? Putting him into orbit after he has been in that ballistic flight, I think, might be an anticlimax.

Has he not gone through everything when he goes through that flight that he does while in orbit?

Dr. SILVERSTEIN. Not really. Let me put it this way: We put him into this ballistic flight and he is in effect under less severe conditions than he will encounter in the orbit. The recovery process is not so difficult as in the orbit but he will have a chance to endure some of the accelerations. When you get him in the ballistic flight he will have a chance to experience some of the weightlessness that he will encounter over a much longer period of time. In the ballistic flight he will be weightless only for a matter of 6 minutes, whereas in the orbital flight he might be weightless for a matter of 4½ hours.

This will give us a preliminary picture for the manned flight and get him accustomed to the environment and this, we think, is necessary in order to be safe.

Mr. RHODES. What do you think this weightlessness will do to a man?

Dr. SILVERSTEIN. We have to learn that.

Dr. GLENNAN. This is one thing we just cannot simulate here on earth.

CAPSULE CONTRACT

Mr. THOMAS. What type of contract do you have with the St. Louis company for your $19.5 million on your 12 capsules? Is it cost-plus?

Dr. SILVERSTEIN. Cost-plus-fixed-fee.

Mr. THOMAS. How did you arrive at the fee and what supervision do you have over the expenditure? What control do you have?

Mr. SIEPERT. The figure we derived at by haggling and refining cost estimates of the actual job and then arriving at a reasonable amount. I think in this case it was 6 percent.

Dr. GLENNAN. 6.28 percent.

Mr. THOMAS. What part of the overhead of the plant is carried in your contract? What part of the depreciation of the plant is carried in your contract? What part of the managerial costs go in your contract over and above the 6.28 percent?

Mr. SIEPERT. Only that part of the company's total expense which the auditors for the whole Government allow. If we have 20 percent of the Government contract business——

Mr. THOMAS. If you tie it up with a contract, the General Accounting Office cannot break the contract.

Mr. SIEPERT. The overhead amount that goes into our contract is that portion of the total overhead of the company which one audit agency for the whole Government, in this case Navy, determines to be the amount of allowable cost—if we have 10 percent of the total Government business in the company's plant we will take 10 percent of the allowable indirect costs of the company against our contract, no more.

Mr. THOMAS. Is the Navy spending your money here?

Mr. SIEPERT. No. Under our relationships with the military, whenever we go into a direct contract with a plant which is primarily doing defense business, we have the military plant representatives handle the administrative relationships on our contracts. This keeps us from duplicating services in the same plant.

Mr. THOMAS. How did you pick this plant?

Mr. SIEPERT. You mean, how was the McDonald Co. picked?

Mr. THOMAS. Yes.

Dr. GLENNAN. Thirty-seven companies were invited to bid, companies all over the United States. Eleven finally came in, as I recall it, with bids. One of the bids was unresponsive and was thrown out. Ten remained.

One contract evaluation board was set up on the technical side, a second contract evaluation board was set up on the business side. These two, making their evaluation on a wide variety of factors, brought their recommendations to a single evaluation board, which Dr. Silverstein chaired, and he, having listened to their story, satisfying himself as to the validity of the examination made by those boards, brought it to Dr. Dryden and me, and we finally accepted the findings of Dr. Silverstein.

At this point we then selected the company, McDonald, in this instance, which showed up best in this competitive examination. By the way, the military services were members of our boards. From that point we negotiated with the successful bidder.

Mr. THOMAS. You had competition in that 10 or 12 companies offered their services for a fee?

Dr. GLENNAN. They submitted competitive prices, but when one is developing an item like this where one cannot sit down and draw up all the specifications and all the blueprints on it, the cost-plus-fixed-fee route is about the only route one can go. It is really a competitive negotiation we are talking about.

Mr. OSTERTAG. In connection with your cost factors, in connection with your evaluation, it strikes me that one of the gray areas here with regard to your whole program has to do with the possible synchronization of production and cost with that of the military. In other words, most or much of this function of production and equipment and satellites is being produced and developed for the military.

Is it possible that you are paying a separate price or a separate consideration, or does the development and the cost factor have a part and parcel of the development that took place under the military as a part of your evaluation in your pricing?

Dr. GLENNAN. In evaluating these bids we go back to the military services and say, how have these various companies performed? How have they kept to their schedules? What is their management performance? What is their record of meeting the costs which they have estimated for you as they come into this competitive situation?

This is a very, very thorough process. There is much probability that in many of these devices we are building that airplane companies particularly will be interested, or engine companies, that have been in this same field—we always try to get outsiders as well—but because there is so much probability they will be in it we attempt to get representatives of the armed services on our committee so we get the value of their background information and experience.

Mr. OSTERTAG. Whether it be boosters or component parts of the ATLAS, how do your prices compare with that of the military?

Dr. GLENNAN. We buy our ATLASES from the Ballistic Missile Division, from the military.

Mr. OSTERTAG. You buy them from the military rather than from contractors?

Dr. GLENNAN. From the military.

Mr. YATES. Is that at original cost or depreciated cost?

Dr. GLENNAN. We would like to have credit for our testing of their boosters, but we do not get it.

SPACE RENDEZVOUS TECHNIQUES

Mr. YATES. The impression I get from your justification on page 260 entitled "Space Rendezvous Techniques" is that you really have a ceiling unlimited in connection with your thinking.

How serious are you about the space laboratories floating up above the atmosphere and looking for the placement of men and machines in order to have a landing space for your space flights? Is that within the realm of possibility?

Dr. SILVERSTEIN. Very much so. I think myself that one broad statement I could make in this area from my point of view in this whole space flight area is that no one, to my mind, has defined a place where we stop flying as we go up. In other words, I do not see the line really where space begins and the air stops because the atmosphere gets more and more tenuous as you go up, thinner and thinner, but it is going up all the time.

We have had places before when people drew lines and said that you are not going to fly faster than the speed of sound, for instance. We flew through it. Other people have drawn arbitrary lines. They say that this is space and this is air. I see nothing that will stop us from doing it if we are properly funded. I think these are the kinds of things that are going to be done. There is no question about it.

I think Dr. Dryden mentioned the point that if somebody had asked the Wright brothers back in 1903 to visualize what was going to happen in flight ahead they could not have done it. I talked to Orville Wright in 1930 when he came through our laboratory at Langley. I was there. He looked at the airplane sitting in our tunnel at that time. It was one of the modern airplanes of 1930, which flew at a speed of about 175 miles an hour. He looked at it and said, "You know, I would never have dreamed we would have an airplane that would go this fast or equipment such as this that would be able to test it." This was Orville Wright himself.

I do not think any of us can afford not to look ahead. The future stretches ahead of us. We will do these things. The question is: Are we as a nation going to take the lead? We spend billions of dollars trying to make friends with our neighbors by giving them money. At the same time, we lose all of our leadership by not moving ahead aggressively. This country has the technology and capability. All we have to do is demonstrate it and make friends of these people and demonstrate our leadership.

Mr. YATES. Make friends of these people?

Dr. SILVERSTEIN. The undecided people of the world.

Mr. YATES. I was thinking of space people.

Dr. SILVERSTEIN. This space thing has a tremendous effect on our relations with the world. Either we demonstrate we are a first-class nation or we demonstrate otherwise. I feel that we are going to do these things because they are the things that are the next step in our technological development.

VALUE OF SPACE RESEARCH

Mr. YATES. Suppose a constituent asks you, "Mr. Silverstein, what do you hope to gain by branching out into space other than charting the unknown?" Is this solely the answer? Are there tangible results?

Dr. SILVERSTEIN. There are many tangible results. This communications is an immediate thing.

Mr. YATES. You mean as far as meteorology is concerned?

Dr. SILVERSTEIN. Meteorology is immediate. There are many things in this whole area. I think there will be travel in space. There are people who do not think this. This is my opinion. I think everybody is entitled to his opinion. I think we will do these things like the space rendezvous. They are the next step. You always take the next step.

Mr. YATES. You mean the landing platform in space?

Dr. SILVERSTEIN. Yes, sir. I do not question it.

Mr. WYATT. At this point we are not talking about landing platforms in the sense you are, I believe. We are speaking of the capability of putting up essentially permanent stationary things, and we are not looking at a point from which we would leave to go someplace else. This may well come along.

Mr. YATES. Did I not read in your justifications about having landing stations in space and is this not a part of it?

Dr. SILVERSTEIN. These are some of the initial studies leading toward it. They would be landing contact points.

SPACE RENDEZVOUS TECHNIQUES

Mr. YATES. Put pages 260 and 261 into the record.

(The pages referred to follow:)

SPACE RENDEZVOUS TECHNIQUES

Fiscal year 1959	
Fiscal year 1960	$3,000,000

1. Objectives

To determine system requirements and to develop system components necessary for the accomplishment of contact rendezvous between satellites or space vehicles.

2. Justification

For the conduct of advanced space flight investigations it will be necessary to provide vehicles with a capability for attaining or changing precision orbits or trajectories, and for executing controlled rendezvous in space. Such flight operations are fundamental, for example, to the operation of fixed-altitude and stationary satellites, to the construction of complex vehicles in space, and to the transfer of personnel and materials in the operation of orbiting space laboratories. The development of such operational capabilities is a basic objective of the NASA space vehicle development program.

3. Program phasing

During the fiscal year 1960, it is planned to undertake basic studies to establish effective methods for providing the various required types of vehicular space path control. Preliminary investigations will also be undertaken to devise practical components, including referencing, target acquisition, director, propulsion, and control systems associated with such operations. It is expected that the state of the art will also permit the initial design and development of vehicular subsystems necessary for the more elementary maneuvers involved in, for example, the circularization of an elliptical satellite orbit.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Study of space maneuver techniques		$300,000
Preliminary investigation of referencing, target acquisition, director, propulsion, and control system components		700,000
Prototypes and operational hardware:		
Design, development and construction of satellite orbit-control systems		1,500,000
Supplies, equipment, repairs, and alterations:		
Components, materials, and simulation equipment required for space path control experiments		500,000
Total		3,000,000

Mr. THOMAS. How are you going to spend this $3 million? This is fresh money now. Where are you going to spend it? You have $500,000 for components, materials, and simulation equipment. You have $1.5 million for prototypes and operational hardware. You have $300,000 for study of space maneuver techniques and $700,000 for preliminary investigation of referencing, target acquisition, and so on. How much are you going to spend on that landing platform? This is an estimated figure again.

SPACE PROPULSION TECHNOLOGY

SOLID FUEL ROCKETS

We will put pages 262 and 263 in the record.
(The pages referred to follow:)

SOLID FUEL ROCKETS

Fiscal year 1959	$700,000
Fiscal year 1960	3,000,000

1. Objectives

To improve the utility and versatility of solid propellant rockets by (1) developing improved burning grain configurations; (2) devising methods for thrust vectoring; (3) devising methods for thrust modulation and thrust termination; and (4) reducing the weight of inert parts.

2. Justification

As compared to liquid propellant rockets, solid propellant rockets have several inherent advantages. They are storable, reliable, utilize simple operating principles, are generally transportable in a loaded condition, and offer advantages of simple firing techniques for relatively untrained launching crews. Their general characteristics and the ability to manufacture them readily in different sizes make them attractive for such uses as upper stage boosters, retrorockets, and guidance-correction rockets for space systems.

The utility of solid propellant rockets is limited by a present inability to control thrust during burning, to terminate thrust precisely with a fraction of the charge unburned, to reignite after initial burning and to obtain simple thrust

directional control. The proposed program will aim at an improvement of each of these deficiencies. In addition, research and development efforts will be aimed at the reduction of the weights of cases, nozzles, throat inserts, and other inert parts, thereby improving the overall efficiency of the solid propellant rocket.

3. Program phasing

Studies of the problems and requirements of retrorockets will be initiated in 1959 and continued in 1960. Studies of improved propellant combinations will be initiated in 1960. Prototype rockets having improved construction techniques (lighter weights) will be developed in this time period. Advanced thrust modulating and thrust vectoring systems on small scale rockets will be started in 1960.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Studies of retro-rocket systems	$100,000	$200,000
Studies of high impulse propellants		600,000
Prototypes and operational hardware:		
Advanced-construction rockets	400,000	1,000,000
Advanced thrust modulating and thrust vectoring systems		800,000
Supplies, equipment, repairs, and alterations:		
Components and materials for experimental investigations	200,000	400,000
Total	700,000	3,000,000

Mr. THOMAS. What about solid fuel rockets? I know you will want to do this in your own stomping ground out at Cleveland. Do you not have most of the answers already? You say:

To improve the utility and versatility of solid propellant rockets by (1) developing improved burning grain configurations; (2) devising methods for thrust vectoring; (3) devising methods for thrust modulation and thrust termination; and (4) reducing the weight of inert parts.

You have been carrying on this experiment for a good many years out at your powerplant in Cleveland, have you not?

Dr. SILVERSTEIN. Not in solid rockets, sir. We have worked in liquid rockets.

Mr. THOMAS (reading):

Studies of the problems and requirements of retrorockets will be initiated in 1959 and continued in 1960.

What is a retrorocket?

Dr. SILVERSTEIN. You will recall Dr. Dryden's presentation yesterday of the Mercury capsule. We have small solid rockets in the nose of the capsule to slow it down.

Mr. THOMAS (reading):

Studies of improved propellant combinations will be initiated in 1960. Prototype rockets having improved construction techniques (lighter weights) will be developed in this time period.

What is the metal you are experimenting with?

Dr. SILVERSTEIN. There are marked developments in this area. We are working with materials for solid cases with strengths up to 300,000 pounds per square inch. You might recall that conventional construction steel you use in a building has a strength of around 70,000 pounds per square inch. These materials are four to five times as good.

Mr. THOMAS. What are they?

Dr. SILVERSTEIN. A special Swedish steel being developed, with high tensile strength, by particular methods of heat treatment.

Mr. THOMAS. Supplies jump from $200,000 to $400,000; advance construction, $400,000 this year to $1 million. Studies of high impulse propellants, $600,000. What do you mean by high impulse propellants?

Dr. SILVERSTEIN. Impulse means the thrust you get per pound of fuel burned. In your automobile you have a certain amount of horsepower per pound of fuel burned. We talked about the thrust here per pound of fuel burned.

Mr. THOMAS. What is the nature of the fuel you are experimenting with?

Dr. SILVERSTEIN. The fuels we have been using are basically a combination of a rubber fuel and so-called perochlorate or oxidizer mixed with it to give your combustibles, an oxidant and a fuel. There are new things that have more thrust.

Mr. THOMAS. I am sure the committee wishes you well on that rubber idea because we have several pounds in that stockpile that needs rotating.

What is the chemical formula for rubber?

Dr. SILVERSTEIN. Rubber is one of the very long molecules and has carbon aboard it and organic material.

Mr. THOMAS. It is mostly a carbon, is it not?

Dr. SILVERSTEIN. Not mostly a carbon. It is a carbon, what we call carbon-hydrogen combinations, hydrocarbons. You start with petroleum fuels in making some of the rubbers.

Mr. THOMAS. Synthetic rubber is made from petroleum, any carbon, grain alcohol, any substance, it is a good part carbon, is it not?

Dr. SILVERSTEIN. It is hydrogen and carbon mixed.

Mr. THOMAS. This figure of $3,000,000 is largely an estimated figure, I presume. Where are you going to spend this money?

Dr. SILVERSTEIN. This will all be by contract with the industry that is developing these things.

Mr. THOMAS. How many contracts will you have? You say, studies for high impulse propellants. How many contracts will you have for the $600,000?

Dr. SILVERSTEIN. I would guess about three.

Mr. THOMAS. How about the advanced-construction rockets for $1 million? How many contracts?

Dr. SILVERSTEIN. There will be a number. We have not established these contracts in detail yet. We do not have the funds for them.

Mr. THOMAS. You will not be able to do that at your own laboratory?

Dr. SILVERSTEIN. We will not do this at the laboratories. We will do this on contract. There is a tremendously strong industry growing up in this area with many ideas. These ideas will lead us to advanced technology.

Mr. THOMAS. You mean it is part of the aviation industry?

Dr. SILVERSTEIN. It has grown up as a result of the missile industry.

HIGH ENERGY PROPELLANT ROCKETS

Mr. THOMAS. High energy propellant rockets. We will put in pages 264 and 265.

(The pages referred to follow:)

HIGH-ENERGY PROPELLENT ROCKETS

Fiscal year 1959	$7,000,000
Fiscal year 1960	5,000,000

1. Objectives

To conduct basic investigations of high-energy fuels; to develop medium-size rocket vehicles using these fuels; and to initiate design studies leading to large high-energy rocket vehicles.

2. Justification

Fuels of relatively low energy were used in early rockets, both liquid and solid. The present generation of large rockets uses liquid fuels of moderately high chemical energy such as liquid oxygen and kerosene. A newer class of fuels, of significantly higher energy, has been tested for several years in small, experimental rockets. The most promising of these new fuel components are hydrogen, fluorine, and hydrazine. Through the use of these newer fuels it will be possible to substantially increase the payload carrying capacity of the present generation of large rockets. For example, a two-stage rocket that uses oxygen and kerosene as fuels can put 4,000 pounds in orbit around the Earth and can send 750 pounds to Mars. By using hydrogen in place of kerosene in the upper stage only, the payload capability can be increased to 8,000 pounds for the Earth satellite and 1,500 pounds for the Mars probe for the same launch weight.

Sufficient experience with the new high-energy fuels has now been obtained to proceed with the development of large engines intended for use in rocket vehicles. Preliminary design of the vehicles will proceed concurrently with the engine development so that a useful product will result.

3. Program phasing

Since the oxygen-hydrogen combination is currently considered the most promising high-energy fuel combination for practical use, the development effort using these fuels has been initiated. Strong support is required to maintain a reasonable development schedule on this urgently needed rocket powerplant. The development of a final stage using storable propellants (nitrogen-tetroxide and hydrazine) is to start in 1959. An experimental investigation of the fluorine-hydrogen combination is being continued. Finally, design studies and experiments leading to a hydrogen-oxygen engine of 50,000 to 100,000 pounds thrust will be continued.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Experimental investigation of fluorine and hydrogen as fuels	$1,000,000	$1,700,000
Design studies and experiments leading to a hydrogen-oxygen engine of 50,000 to 100,00 pounds thrust level	1,000,000	1,700,000
Prototypes and operational hardware:		
Development of an upper-stage rocket using oxygen and hydrogen as fuels	2,000,000	
Development of an upper-stage rocket vehicle using nitrogen-tetroxide and hydrazine as fuels	3,000,000	1,600,000
Total	7,000,000	5,000,000

Mr. THOMAS. You are asking for $5 million this year against $7 million last year. This is to conduct basic investigations of high energy fuels, to develop medium size rocket vehicles using these fuels,

and to initiate design studies leading to large high-energy rocket vehicles.

What is the difference between this and the other item?

Dr. SILVERSTEIN. These are liquid fuels as contrasted with the solid.

Mr. THOMAS (reading):

Fuels of relatively low energy were used in early rockets, both liquid and solid.

You have been experimenting at Cleveland for the last 10 or 15 years, have you not?

Dr. SILVERSTEIN. Yes, sir; different parts of this.

Mr. THOMAS. You spent $7 million last year. Did you spend it at the Cleveland laboratory?

Dr. SILVERSTEIN. In this set of figures, go down to the third line and you will see an item for $2 million. The Cleveland laboratory has been given the responsibility of obligating this sum.

Mr. THOMAS (reading):

A newer class of fuels, of significantly higher energy, has been tested for several years in small, experimental rockets.

Is that it?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS (reading):

For example, a two-stage rocket that uses oxygen and kerosene as fuels can put 4,000 pounds in orbit around the Earth and can send 750 pounds to Mars. By using hydrogen in place of kerosene in the upper stage only, the payload capability can be increased to 8,000 pounds for the Earth satellite and 1,500 pounds for the Mars probe for the same launch weight.

Where is all this money going to be spent?

Dr. SILVERSTEIN. This year we are spending $2 million on the third item through contracts let at the Cleveland laboratory. We have a contract with the Bell Co. up in Buffalo for the development of the fluorine as an oxidizer and hydrogen as a fuel. That work is going on now and we will continue it next year. We are working with oxygen and hydrogen with Aerojet Corp. to develop one of the larger sized hydrogen-oxygen engines.

Mr. THOMAS. You have four or five items set out here. You have experimental investigation of fluorine and hydrogen as fuels, $1,700,000. Is that a pure study of a fuel?

Dr. SILVERSTEIN. It is a rocket study.

Mr. THOMAS. You cannot study the fuels unless you burn them in something; is that right?

Dr. SILVERSTEIN. That is right. We have a contract currently which will be continued for a rocket.

Mr. THOMAS (reading):

Development of an upper stage rocket vehicle using nitrogen-tetroxide and hydrazene as fuels—

$3 million this year and $1,600,000 for next year.

Dr. SILVERSTEIN. This $3 million is a development of a rocket that initiated the work for the upper stage of the VEGA vehicle.

Mr. THOMAS. I do not understand why you cannot do all this work at your great installation. How many people do you have in Cleveland?

Mr. ULMER. About 2,800.

Mr. THOMAS. Why do you have to go outside? You could not test any of these fuels without something to test them in.

Mr. ABBOTT. The Lewis Research Center is a research center, not a development group. In order to develop these rockets—well, I should back up.

In the research work on the rockets at Lewis we simply used very small rockets constructed in our own shops at Lewis.

Mr. THOMAS. With that great setup out there, with 2,800 people and a plant investment out there of $100 million or $125 million, and it looks to me as though you were in business long before the people you are now dealing with were in business. You were the father of the whole idea, and you were in business 15 years before these people you are now giving contracts to were in business. Am I right or wrong?

Mr. ABBOTT. I would still like to point out the difference.

Mr. THOMAS. Am I right or wrong?

Mr. ABBOTT. You are partially right and partially wrong. There is a difference between a research laboratory and the industrial setup which is needed for development. It is similar to the chemical business, where you might have a chemical research laboratory which operates on bench size setups, but the industrial setup has to go from these small and sometimes bench size pilot plants to the large installations which are needed to make chemicals on an industrial scale.

The same way on this sort of thing. We have been conducting research work on small objects, which we can either build in our own shops or which we have obtained from other people largely on the basis of obtaining articles, such as the jet engines we worked on out there for a long while, from the military where they were developed by the military in industrial organizations.

Now we are up against the same thing on the rocket business. We can and will continue to do the research work at Cleveland, but we do not have at Cleveland the industrial setup needed to do this work in either liquid or solid propellants.

To go back to the solid propellants, to make these big cases you have to have industrial machinery needed to form and heat treat these very large steel cases, for instance. You have to have the batch plants which will mix these batches of very explosive propellants. We do not have them. We have some in very, very small sizes capable of mixing a very little bit of batch, but we cannot make a batch to go into a reasonable size rocket.

It is the same on the liquid fuels. We can make in our shops or obtain from development in the military a certain number of rockets, but now we are in position where we have to stand a little more on our own feet. We want rockets for our own purpose, and the only place to get them is by contract with industrial firms who are set up to do it. It could be done at Cleveland if one wants to stop the research work and make the capital investment at Cleveland which would be necessary to install this machinery at Cleveland. This would be a very wasteful thing to do. It would be a slow thing to do.

Mr. THOMAS. Doctor, you are the most convincing man I have talked to in years. If you will just stop there, we will say you are right and we are wrong. Is that all right?

Mr. ABBOTT. Yes, sir.

Mr. THOMAS. Is that a satisfactory trade with you, Doctor?

Dr. DRYDEN. I think we should realize that we are talking through this R. & D. budget and we are talking about buying the services of large organizations to develop objects. In many of these cases there are more people involved in the factory in engineering groups and in developing a single one of the things we are mentioning to you than in the whole Lewis Laboratory. We have a tremendous industrial plant in this country. If we tried to duplicate industrial plants, we would have to build up another——

Mr. THOMAS. There is $5 million here, and you are going to spend $2 million of it in your Cleveland plant and the other $3 million you will contract out with the rocket makers for prototype rockets? When they make them, they will deliver them to your plant at Cleveland and there you will test them with certain types of fuels; is that the situation?

Dr. SILVERSTEIN. In some cases we will deliver them to Cleveland, in other cases they will test them at their plant.

Mr. THOMAS. How many contracts do you have with outside concerns for the rockets?

Dr. SILVERSTEIN. In the fiscal 1960 funding here there will be perhaps three contracts within this framework of $5 million.

Mr. THOMAS. Three contracts?

Dr. SILVERSTEIN. Yes, sir.

1 TO 1½ MILLION-POUND-THRUST SINGLE-CHAMBER ENGINE

Mr. THOMAS. Let's look at your single-chamber, 1 to 1½ million-pound-thrust engine. You are really getting upstairs now. This is $30,200,000. We will put pages 266 and 267 in the record.

(The pages referred to follow:)

1 TO 1½ MILLION-POUND-THRUST SINGLE-CHAMBER ENGINE

Fiscal year 1959	$10,000,000
Fiscal year 1960	30,200,000

1. Objectives

To provide a capability for launching very large payloads by developing a million-pound-thrust single-chamber rocket engine for use in a booster rocket system. The higher thrusts required for even more advanced space missions will be attained by clustering several of these rocket engines.

2. Justification

For missions aimed at boosting large manned vehicles into orbits around the earth and for missions aimed at delivering large instrumented payloads to the planets, rocket system having thrust levels significantly greater than the capability of present ICBM boosters are required. Systems based on current ICBM's with high-impulse propellant upper stages will be able to deliver approximately 8,000 pounds into an earth orbit and approximately 1,500 pounds in a planetary probe. A million-pound rocket first stage with a current ICBM as the second stage and a high-energy propellant third stage would deliver approximately 15 tons into an earth orbit and 5 tons on various interplanetary missions. Such payloads will be required for advanced manned vehicles orbiting around the earth. A booster of the proposed magnitude is also required for instrumented payloads which will be landed on the near planets to explore and investigate the nature of these planets in detail. For missions aimed at manned flight to various interplanetary objectives, significantly higher thrust levels will be required. These will be attainable by clustering the million-pound-thrust motors to produce a 5- to 6-million-pound total thrust.

3. Program phasing

Fiscal year 1959 funds will be used to support component research and design analyses for high-thrust rockets. During the fiscal year 1959, a contract will be let for the design, fabrication, and development of the million-pound-thrust rocket. Fabrication of components will be started and will be continued into the fiscal year 1960. The engine is to be completed within 4 years.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Prototypes and operational hardware: Design, fabrication, and development of the 1,000,000-pound thrust rocket; fabrication of components	$10,000,000	$30,200,000
Total	10,000,000	30,200,000

Mr. THOMAS (reading):

To provide a capability for launching very large payloads by developing a million-pound thrust single-chamber rocket engine for use in a booster rocket system. The higher thrusts required for even more advanced space missions will be attained by clustering several of these rocket engines.

We went into this slightly on two or three occasions.

For missions aimed at boosting large manned vehicles into orbits around the earth and for missions aimed at delivering large instrumented payloads to the planets, rocket systems having thrust levels significantly greater than the capability of present ICBM boosters are required.

We are trying to catch up with the Russians; is that right?

Dr. GLENNAN. Only partially that. In order to do the job we have ahead of us——

Mr. THOMAS. I am talking of powerplants. This is primarily a powerplant.

Dr. DRYDEN. We think it is bigger than any the Russians have. As testified, it will be 4 or 5 years before we complete this development.

Mr. THOMAS (reading):

Systems based on current ICBM's with high impulse propellant upper stages will be able to deliver approximately 8,000 pounds into an earth orbit and approximately 1500 pounds in a planetary probe.

What was the biggest payload the Russians placed in orbit?

Dr. DRYDEN. About 2,900 pounds in orbit.

Mr. THOMAS. How high was that?

Dr. GLENNAN. 135-mile perigee. The apogee was 1,167 miles.

Mr. THOMAS. What you are working on will carry up to that same height 8,000 pounds, 3½ times what the Russians have?

Dr. SILVERSTEIN. This million-pound rocket will do more than that. It will carry a load—used individually, it will put about 25,000 pounds in orbit.

Mr. THOMAS (reading):

For missions aimed at manned flight to various interplanetary objectives, significantly higher thrust levels will be required. These will be attainable by clustering the million-pound thrust motors to product a 5- to 6-million-pound total thrust.

You are going to use a cluster and put three or four or five of them in a cluster?

Mr. THOMAS (reading):

Fiscal year 1959 funds will be used to support component research and design analyses for high-thrust rockets. During the fiscal year 1959 a contract will be let for the design, fabrication, and development of the million-pound-thrust rocket. Fabrication of components will be started and will be continued into the fiscal year 1960. The engine is to be completed within 4 years.

You are spending $10 million in 1959, $30,200,000 in 1960. What will it cost when you get it completed by 1964 or 1965?

Dr. SILVERSTEIN. The contract we have entered into is for $102 million.

Mr. THOMAS. Where is it made and who is the contractor?

Dr. SILVERSTEIN. The contract is with the Rocketdyne Co. of the North American Aviation Corp.

Mr. THOMAS. Is that in Los Angeles?

Dr. SILVERSTEIN. North of Los Angeles.

Mr. THOMAS. $102 million. What type contract is it?

Dr. SILVERSTEIN. It again is a cost-plus-fixed-fee contract.

Mr. THOMAS. Whose company is this?

Dr. DRYDEN. J. H. Kindelberger's company. Sam Hoffman is chief of the Rocketdyne Division.

Mr. OSTERTAG. Does not all this information in regard to your program here give Russia and anyone else a complete picture of just how far you are going, where you are?

Dr. DRYDEN. It certainly gives a fair picture. You will recall that the law under which we act has a very specific requirement to give information—I have forgotten the language—to be as open as possible in the information about space, other than that classified for military security.

As you remember, the other day we thought we should not put in an open record the detailed planning of particular missions and flights. We are not making available, of course, the details of this engine, the materials of which it is made, the exact arrangement of its parts or anything of that nature.

Mr. THOMAS. How do you arrive at the figure of $102 million over a period of 5 years?

Dr. DRYDEN. This is the estimated cost of the development.

Mr. THOMAS. Who made the contract? How do you estimate the cost? When was it made?

Dr. DRYDEN. The contract was entered into on January 9, 1959, between our organization and the North American Aviation Corp.

Mr. THOMAS. You mean you did not inherit this? It was made by NASA?

Dr. DRYDEN. That is correct. We inherited a study on the feasibility of such engine. This study contract was transferred from the Air Force.

Mr. THOMAS. What is the fee and what part of the overhead of the present company supports this contract?

Mr. SIEPERT. The fee is 6.5 percent. This $102 million is the result of a very detailed negotiation with the company after having assured ourselves that their proposal was the best technical and the best economical proposal. We had five companies that submitted proposals to us.

Dr. DRYDEN. Five companies submitted proposals on this engine. It was a competitive negotiation.

Mr. THOMAS. What kind of brains do we have with this organization that can negotiate a $102 million contract? Who is making it? How much experience did they have in the procurement field in this type of work?

Dr. DRYDEN. We have a number of people who have excellent experience in the procurement area. As Mr. Siepert told you, we obtained one of the best men at Wright Field in this business, one of the experts. The contracts were evaluated in the procedure that has been commonly used of setting up a committee to evaluate the technical aspects of the proposals, and setting up a different committee to evaluate the business aspects of the proposal.

In that group we had the advice of senior procurement officials in the military services. These two groups reported to an overall——

Mr. THOMAS. You mean the Air Force?

Dr. DRYDEN. From Wright Field. The Air Force has some interest in the possible later military use of this engine, although they have not formulated any requirement at the moment. The military use of space is a thing which is not fully formulated as yet.

Mr. THOMAS. This is new ground for you folks to be traveling in.

Dr. DRYDEN. It is a new agency, new people.

Mr. THOMAS. You are plowing in virgin soil. You tie up the taxpayers for $102 million right off the bat. It is easy to tie up but awfully hard to get untied.

Dr. GLENNAN. Really, it is not.

Mr. YATES. Is there a cancellation clause in the contract?

Dr. DRYDEN. Certainly.

COST OF SPACE PROGRAMS IN FUTURE YEARS

Mr. YATES. This thought that occurs to me is: How much will your program cost over the next few years? How far ahead have you planned?

Dr. GLENNAN. We are in the process of trying to draw out into the future what we think this would cost if we go along at a sound, well-planned pace. It would appear to me that this agency would be spending, would be asking for money in the neighborhood of a billion dollars a year within the next 3 years.

Mr. YATES. For how many years at a billion dollars a year?

Dr. GLENNAN. So long as the Nation wants this program carried on.

Mr. BOLAND. There comes a point where you will have learned all you can learn with respect to the hardware you have to purchase; is that right?

Dr. GLENNAN. I might say that there might be a decrease in years, say beyond 5 or 6, whatever it might be, when the development costs on some of these very expensive vehicles were behind us and you then bought the vehicles at so much per copy. Because of the tremendous weight-carrying capacity, you would not be buying very many. Those costs might come down somewhat.

Mr. BOLAND. We are engaged in a lot of research to put man in orbit, to put up communications stations, to put up satellites. You

will find this out and the great cost is in developing this thing. After it is developed, all you have is the cost of production.

Mr. YATES. Does private enterprise enter into this? Is this something the Government is mapping out for private enterprise? Do you visualize the time when you will have interplanetary travel the same as we now have intercontinental travel?

Dr. DRYDEN. You might compare this new area with the atomic energy field with which you are familiar. Does anyone think the Nation will abandon that field? I do not think so. In the same way, as space develops there are going to be civilian and military uses and I do not think this is a new activity of mankind that you kind of study for a while and then it disappears completely.

Mr. OSTERTAG. You regard this as a perpetual sort of thing?

Mr. YATES. Permanent.

Dr. DRYDEN. It is completely new technology, a new area, and it will go on at some pace.

Mr. YATES. That is why I wondered about the cost of this. I had not really gone beyond this budget in terms of cost until suddenly it occurred to me you are developing the VEGA over 8 years and you are not going to stop with the development of the VEGA. The VEGA is only one piece of this total program. Where do you go? How much is all this going to cost the American taxpayers?

Dr. DRYDEN. It is like the shipbuilding activities. You do not finance those in annual budgets. They are things which inherently take a long time to do. The same way with the airplanes.

Mr. YATES. With shipbuilding you have an idea as to limitations. You can visualize. There is a sort of ceiling unlimited on the cost of this program.

Dr. DRYDEN. I do not think so.

Mr. YATES. Do you have any limitations that tie this in? You just envision this as costing a billion dollars a year?

Dr. GLENNAN. We have been in business 8 months in a wholly new field. I think a year from now we could answer your question very much more intelligently and sensibly than we can today.

Mr. YATES. A year from now I will ask you the question again.

Dr. GLENNAN. You make a note to do that.

Mr. RHODES. I doubt if you will be able to tell a year from now. This is like asking Orville Wright how much money would be needed to develop the aviation industry after he had flown his plane for two minutes.

Dr. GLENNAN. We will have a better grasp of it than we have now. In the agricultural research business we are not about to cut off agricultural research. Look at the dividends that have come back to the taxpayer from that over the years.

Why kid ourselves about it? If the public does not want it, you can cut it off.

Mr. YATES. The public should have an idea.

Dr. GLENNAN. We are trying to be honest and forthright.

Dr. DRYDEN. Some people say it ought to be $2 billion. We do not think so. We started with an estimate last year and everybody said we are not asking enough.

Mr. OSTERTAG. I would say on the one hand we are rather fortunate that we can get into this thing and have what it takes to move ahead with it.

Mr. YATES. I keep thinking of the line from Robert Browning's poem to the effect that a man's reach should exceed his grasp.

NUCLEAR ROCKET ENGINES

Mr. THOMAS. We will put pages 268, 269 and 270 in the record. (The pages referred to follow:)

NUCLEAR ROCKET ENGINES

Fiscal year 1959	$4,500,000
Fiscal year 1960	8,000,000

1. Objectives

To develop the nuclear powered systems that must be used to deliver large payloads to various space objectives. More specifically the objectives are: to conduct investigations of reactors suitable for application to nuclear rockets, to develop turbopumps and associated propellant feed equipment, to develop methods of cooling parts that are heated by nuclear as well as by thermal radiation, to develop lightweight shield configurations to protect sensitive equipment and personnel from nuclear radiation, to develop methods of controlling the reactor systems, and to investigate other problems associated with operation of nuclear systems.

2. Justification

There two two principal types of nuclear power systems applicable to propulsion devices. The first is the heat transfer rocket in which a low molecular weight gas is heated to high temperature in the nuclear reactor. This high temperature gas is then expanded through a jet nozzle producing thrust. The second system is one in which the heat generated in the nuclear reactor is converted to electrical energy by some thermal conversion system. The electrical energy may then be used in a wide variety of ways to produce thrust. For instance, it may be used to accelerate ions to high velocity or it may be used to heat and accelerate a plasma out through a jet nozzle. The first type of nuclear system will be referred to as the nuclear heat transfer rocket; the second system will be referred to as the nuclear electric rocket.

Nuclear heat transfer rocket.—Because of the low molecular weight of the gas discharged from the jet nozzle and the high temperature of the gas, the nuclear heat transfer rocket is capable of achieving specific impulses in the range of 700 to 1,000 seconds as compared with a maximum of about 400 seconds for the high impulse chemical rockets. These high impulses give the nuclear rocket the potential of being able to deliver high payloads into an orbit around the earth with a single-stage rocket. For example, it would be expected that a payload of 30,000 pounds could be boosted into an earth orbit with a single-stage nuclear rocket having a takeoff gross weight of about 250,000 pounds. Using chemical rockets to do this same job would require a three-stage vehicle weighing about a million pounds.

These high impulses of the nuclear heat transfer rocket systems also offer the potential of delivering large payloads to various interplanetary objectives when this nuclear rocket is used as an upper-stage rocket. For instance, with a takeoff gross weight of 1 million pounds, a payload of 6,500 pounds could be delivered to a Mars orbit with a four-stage chemical rocket. Using the first two stages of this chemical system and adding a nuclear third-stage (still giving a gross weight of 1 million pounds) makes it possible to deliver 28,000 pounds into a Mars orbit. In addition, these high impulses permit the use of low power reactor systems to carry large payloads from an Earth orbit to various interplanetary objectives in nuclear space heat transfer rockets.

Nuclear electric rocket.—The nuclear electric rocket will develop extremely high impulse because of the high velocities to which the discharge particles are accelerated. However, the thrust generated will be significantly less than the weight of the system required to generate the electricity so that electrical systems cannot be used to boost a payload from the Earth. It is well suited, however, to propelling a vehicle out in space where the thrust is sufficient to permit the vehicle to leave an established earth orbit and travel to interplanetary objectives. For the advanced space missions in which human crews may travel to distant objectives for exploration or other purposes, the nuclear electric rocket is one of the promising propulsion systems.

Because of the NASA mission to develop vehicles capable of carrying the equipment, supplies, and men that may be needed to explore space, it is necessary that the potential of the nuclear rocket systems be thoroughly evaluated and developed. Because the major obstacles in the way of the development of these rocket systems lie in the reactor, it is necessary that studies aimed at the earliest possible development of high temperature, lightweight reactors be made. Along with this reactor work, studies must proceed on the other components of the system so that these other components will not delay the final full-scale system tests.

3. Program phasing

The program for the fiscal year 1960 is divided into three principal parts in terms of the application of the nuclear power system: (1) continued support of the ROVER program aimed at the development of high-power reactors for earth satellite booster application; (2) studies of nuclear systems for application to upper-stage or space heat transfer rockets; and (3) studies of nuclear power generating systems for early application in electrical propulsion systems. In the ROVER program, the NASA will continue to support development of the nonnuclear components. For the upper-stage heat transfer and electric rockets, system design studies will be made and component fabrication and performance evaluation will be started.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Space nuclear rockets	$1,000,000	$1,500,000
Nuclear electric power generation for propulsion		500,000
Prototypes and operational hardware:		
Rover project (reactor tests)	2,300,000	1,500,000
Space nuclear rocket	1,000,000	2,500,000
Nuclear electric power generation for propulsion		1,500,000
Operations and technical studies: Space nuclear rockets		200,000
Supplies, equipment, repairs, and alterations:		
Rover project	200,000	
Space nuclear rockets		300,000
Total	4,500,000	8,000,000

Mr. THOMAS. Last year you spent $4.5 million and this year you want $8 million to develop nuclear powered systems that must be used to deliver large payloads to various space objectives. More specifically, the objects are: to conduct investigations of reactors suitable for application to nuclear rockets, to develop turbo pumps and associated propellant feed equipment.

What is the difference between this and the one we just discussed? Is it one of size? Is this purely a nuclear proposition and the other was solid fuel?

Dr. SILVERSTEIN. The other was liquid.

Mr. THOMAS. This is purely nuclear?

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. How much study have you made on it at the Cleveland laboratory? You have had a nuclear setup there for 3 or 4 years.

Dr. SILVERSTEIN. We have worked on it at Lewis. The field of research and development relating to the construction of reactors is a function of AEC. They are carrying along currently an experimental program trying to develop the heat exchangers, the nuclear reactors that produce heat. Our job is to provide the rest of the rocket, the shell, cooling pumps, the tanks, the fuel system, and the adaptation of the rocket to the space vehicle. We are working closely with AEC in this combined effort.

Mr. THOMAS. How long have you had your nuclear setup now at Cleveland?

Dr. SILVERSTEIN. We started construction about 2½ years ago at Cleveland on a nuclear reactor, which goes into operation this fall.

Mr. THOMAS. It is not completed yet?

Dr. SILVERSTEIN. It is approaching completion now.

Mr. THOMAS. How much did we spend on that?

Mr. ULMER. About $11 million.

Mr. THOMAS. It is not complete yet?

Dr. SILVERSTEIN. We have not started operations in the facility.

Mr. THOMAS. Is that the turnkey job?

Mr. SIEPERT. Yes.

Mr. THOMAS. Whereabouts is it?

Dr. SILVERSTEIN. West of Cleveland.

Mr. THOMAS. How far out?

Dr. SILVERSTEIN. Fifty miles.

Mr. THOMAS. How much land is it on?

Dr. SILVERSTEIN. On the Plumbrook Arsenal, which we are now occupying.

Mr. THOMAS. Down in Sandusky?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. Where are you going to spend this $8 million, in the laboratory, or where?

Dr. SILVERSTEIN. No, sir; we may spend in the order of a million dollars in an NASA laboratory——

Mr. THOMAS. Where is the other going to be spent?

Dr. SILVERSTEIN. The other will be spent under contract.

Mr. THOMAS. (reading):

> The program for 1960 is divided into three principal parts in terms of the application of the nuclear power system: (1) continued support of the ROVER program aimed at the development of high-power reactors for earth satellite booster application; (2) studies of nuclear systems for application to upper-stage or space heat transfer rockets; and (3) studies of nuclear power-generating systems for early application in electrical propulsion systems. In the ROVER program the NASA will continue to support development of the nonnuclear components. For the upper-stage heat transfer and electric rockets, system design studies will be made and component fabrication and performance evaluation will be started.

Mr. YATES. With whom do you have these contracts, the same companies?

Dr. SILVERSTEIN. We will have contracts with different organizations with the 1960 funds. For example you are aware, I think, of the existence of the so-called Snap program.

Have you heard of this?

Mr. YATES. No.

Dr. SILVERSTEIN. This is a program in which we are trying to develop auxiliary power for space vehicles when you have these long distance flights in space. You have to supply, on a round trip to Mars which would take a thousand days, a source of power to drive your instruments and communication systems. This source of power must be fairly large and when you are out in space in an orbit, and you want to get out of this orbit and move to another orbit, into another trajectory you need this source of power.

In the Snap program the Air Force initiated a program to develop a small system using nuclear heat to heat up a fluid. In some

cases, it might be mercury. You heat it up to boiling point and then you take the vapor generated and pass it through a turbine. You drive the turbine and the turbine drives an electrical generator from which you get electrical power.

As a part of this system, you have to get rid of excess heat through a heat exchanger before you start through the cycle again. Components of this system now exist for about something like 2½ horsepower, but we are aiming our next step to take it up to 10 times that.

Mr. YATES. Is there duplication of the work being done by the AEC and by the Navy in its nuclear program?

Dr. SILVERSTEIN. No, sir. This work was transferred to us by the Air Force. This combination of the AEC working with the Air Force existed up to the time NASA was created. In other words, for these types of equipment largely in space, NASA was established to carry on this basic work and then it was transferred to our jurisdiction after we were created. We are carrying along with the AEC and in the way the Air Force was doing before.

SPACE ENGINES

Mr. THOMAS. What about space engines?

Let us put in pages 271, 272, and 273.

(The pages referred to follow:)

SPACE ENGINES

Fiscal year 1959	$300,000
Fiscal year 1960	3,000,000

1. Objectives

To carry out analytical and experimental investigations of space propulsion systems for journeys originating from orbit about the earth.

2. Justification

The possible engines for space propulsion vary from the light weight but low efficiency types, such as existing chemical rockets that consume a large amount of propellant, to propose types that are very efficient and consume only a small amount of propellant but are also very heavy. For journeys that require very high energies, such as interplanetary flights, the chemical rocket becomes prohibitively heavy. Journeys of this type will require the use of the more efficient space propulsion engines. These engines will, in general, consist of an energy source, conversion equipment and an accelerator. The energy source may be nuclear, solar, chemical or other. The nuclear energy sources are discussed under the program entitled "Nuclear Rocket Engines." The space engines program will be directed at obtaining a high reliability in the conversion equipment and accelerator components and at reducing engine hardware weight so that either the payload may be increased or higher thrust engines may be used to reduce trip times.

Basic research must be conducted on advanced space engines in order to explore the possibilities of all types, and development work must be started on systems now considered the most feasible in order to reduce their weight. The possibility of direct conversion of nuclear energy to produce a high-velocity jet also exists so that research work must be continued in this field.

3. Program phasing

Funds for the fiscal year 1959 will provide for both analytical and experimental studies to determine the capabilities and operating limits of the components of the systems and an evaluation of the overall system to determine the most feasible type for development. Corrosion and mass transfer, for example, will determine the temperature limits to which the engine can be operated.

Funds for the fiscal year 1960 will provide for additional studies and for prototype hardware of certain components that must be built to check out the features of the components and of the entire system. Evaluation and develop-

ment of this type of hardware will eventually lead to operational engines for space flight.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Power conversion equipment	$50,000	$800,000
Acceleration equipment	150,000	200,000
Prototypes and operational hardware:		
Power conversion equipment	50,000	1,100,000
Acceleration equipment	50,000	700,000
Supplies, equipment, repairs, and alterations:		
Power conversion equipment		100,000
Acceleration equipment		100,000
Total	300,0000	300,000

Mr. THOMAS. Who is going to do this work? This is a new program.

Funds for fiscal year 1959 will provide for both analytical and experimental studies to determine the capabilities and operating limits of the components of the systems and an evaluation of the overall system to determine the most feasible type for development.

Funds for the fiscal year 1960 will provide for additional studies and for prototype hardware of certain components that must be built to check out the features of the components and of the entire system.

Where is this work done?

Dr. SILVERSTEIN. Largely by contract.

Mr. THOMAS. You have $300,000 in 1959 against $3 million for 1960. Who is your contractor and where?

Dr. SILVERSTEIN. The contracts for 1960 have not been let. Again, we have planned a program ahead and here we are talking about the type of equipment required to convert the——

Mr. THOMAS. Let me interrupt and say that I am not an expert in this field, but I will tell you one thing. I have found many times it is very easy to get into a contract but it is sure a whole lot harder to get out of one. So, take your time and go easy and be sure you get your money's worth.

Dr. GLENNAN. We cannot contract until we have the money.

Mr. THOMAS. Did I understand you a while ago to say that you had tied yourselves up here on a $100 million contract for 3 or 4 years? That is going to take 5 years?

Dr. GLENNAN. There are cancellation clauses in it.

Mr. THOMAS. I hope they are good ones, Doctor, do you not?

Dr. GLENNAN. If I understand what you mean, I hope that they are good ones, but I do not think that is what you mean.

Dr. DRYDEN. Mr. Chairman, we are trying to be responsible as to how this money is spent. I am sure you understand this is a budget that is planned and you do not outline the contracts you are going to make 18 months ahead in detail. You have to estimate on the basis of past experience and the contracts you have already made as to what will be needed.

We can supply the detail on the 1959 contracts which are actual, but we have no way of supplying information exactly on very many of the 1960 contracts.

I believe you pointed out one which runs through a number of years.

Mr. ULMER. Even in those cases the amount of money that the contractor can commit the Government to is limited to the funds provided us in a given fiscal year.

AUXILIARY POWER UNITS

Mr. THOMAS. We will put pages 274, 275, and 276 in the record at this point.

(The pages referred to follow:)

AUXILIARY POWER UNITS

Fiscal year 1959	$500,000
Fiscal year 1960	3,000,000

1. Objectives

To develop auxiliary power units to obtain low weight and high reliability for a wide range of power requirements from that now required on existing satellites to that which will be required in advanced interplanetary journeys.

2. Justification

Nearly all vehicles to be effective must have auxiliary electric power, in addition to the main propulsion power source, in order to operate the equipment on board. The type of power unit required depends on the rate of power consumption needed and the time for which it must operate. Possible power units vary from lightweight but low efficiency types suitable for short-time operation to the heavier but more efficient types for long-time operation. In some vehicles the auxiliary power may be supplied by the main propulsion unit. All systems require one or more components to convert an energy source to electric power. The system that results in the lightest weight for a given mission will depend on the weight and efficiency of each of the components so that each must be studied and developed.

Auxiliary power units can, in general, be divided into two categories: (1) the chemical cell type which contains a given total energy and is thereby limited in time of operation depending on the rate at which energy is used, and (2) the solar cell type which is limited in power output depending on the size and distance from the sun but which has an almost indefinite life or time of operation. The nuclear powered turbogenerator, like the solar cell, has a very long life limited only by the reactor fuel supply but is capable of being developed to very high power outputs—in the order of megawatts. At the higher powers these units are useful as the power source for the electric space engines.

Existing units are either very limited in operating times when using the chemical cell, or to very low power output when using the solar cells. Initial work will consist of refining these units in order to reduce their weight and increase their power and reliability. These units, however, can never be developed for missions which require travel to long distances from either the earth or the sun. Studies and research will first be made on components leading to advanced nuclear systems. These studies will then be used to determine which units to develop for future interplanetary and interstellar journeys that will be made.

3. Program phasing

Funds for the fiscal year 1959 will be used for studies of various systems to determine their limitations and operating characteristics. These studies will consist of analytical investigations and the construction and tests of component parts that are difficult to analyze. Funds for the fiscal year 1960 are requested for the more detailed study of the systems that appear most promising and for the construction and prototype components of the systems to determine their operating characeristics and efficiencies.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Solar collectors and equipment	$100,000	$100,000
Power sources (except nuclear) and associated equipment	50,000	100,000
Power conversion equipment	50,000	100,000
Prototypes and operational hardware:		
Solar collectors and equipment	100,000	1,000,000
Power conversion equipment	200,000	1,500,000
Power sources (except nuclear) and associated equipment		50,000
Supplies, equipment, repairs, and alterations:		
Solar collectors and equipment		50,000
Power conversion equipment		50,000
Power sources (except nuclear) and associated equipment		50,000
Total	500,000	3,000,000

Space Systems Technology

ADVANCED VEHICLE SYSTEMS

Mr. Thomas. Under "Advanced vehicle systems," you say your objective is "to study the problems arising in the development and use of large rocket vehicle systems."

I thought we had four or five projects here in addition to this one. I do not know whether there is any duplication or not; perhaps so. We will insert pages 277 and 278 at this point. (The pages referred to follow:)

Advanced Vehicle Systems

Fiscal year 1959	$500,000
Fiscal year 1960	1,500,000

1. Objectives

To study the problems arising in the development and use of large rocket vehicle systems.

2. Justification

The NASA has initiated a program for the development of a 1-million-pound-thrust rocket motor. In addition, other programs are underway for the development of rocket motors suitable for use with high-energy propellants as well as research directed toward providing nuclear reactors for rocket propulsion. Rocket motors represent only one part of the complete booster system. Other factors to be considered included the tanks, structure, type of staging, methods for attitude control, prelaunch fuel handling, and operation of the vehicle. Some or all of these areas of interest must be examined at an early date so that the complete booster system reaches developmental stages on a time scale that will allow earliest possible use of the rocket motors.

3. Program phasing

In the fiscal year 1959 predevelopment study contracts will be initiated to study the problems arising in the use of large rocket systems and/or high-energy propellant systems. They will be continued and extended in the fiscal year 1960. Model testing will be started in 1960.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies	$500,000	$1,200,000
Supplies, equipment, repairs, and alterations		300,000
Total	500,000	1,500,000

BOOSTER RECOVERY SYSTEMS

On booster recovery systems, that is money well spent if you learn to recover them. They are pretty expensive.

Let us put pages 279 and 280 in the record.

(The pages referred to follow:)

BOOSTER RECOVERY SYSTEMS

Fiscal year 1959	$500,000
Fiscal year 1960	1,500,000

1. Objectives

To develop vehicles that will be used with high-thrust first-stage rockets so that these rocket systems may be recovered and reused after each launching.

2. Justification

As part of its mission to explore space, the NASA is developing large rocket engines which will be capable of delivering large payloads into an earth orbit or which will be used to boost upper-stage vehicles for long-range interplanetary missions. For instance a cluster of the million-pound-thrust rocket engines can be used to deliver a payload of approximately 150,000 pounds into an earth orbit. These clusters will also be required for the proposed manned lunar missions and for the establishment of permanently manned and therefore permanently supplied space stations from which advanced space missions and operations may be carried on.

It is presently estimated that the hardware cost of each of the clusters of million-pound-thrust rocket systems will be at least $45 million. Because of the extensive use that is proposed for the million-pound rocket and because of the large numbers of these rockets that will be required, it is apparent that means must be found to recover the first-stage booster so that it may be reused. The savings in cost of hardware that would be achieved would pay many times over for the cost of developing a booster system that would be recoverable.

3. Program phasing

The fiscal year 1959 funds for this program will be directed only at analysis of various systems of recovery that appear feasible. In the fiscal year 1960, design and engineering will be conducted and promising concepts will be evaluated using models in wind tunnel and free flight experiments.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Analysis of feasible systems	$500,000	$300,000
Design and engineering studies		900,000
Supplies, equipment, repairs, and alterations: Models for wind tunnel and free flight experiments		300,000
Total	500,000	1,500,000

ORBITING SPACE LABORATORIES

Mr. THOMAS. Under "Orbiting space laboratories," you say your objectives are—

to establish the scientific, technological, and civilian service requirements for orbiting space laboratories; to rationalize and refine the design, construction, and operating technology of orbiting space laboratories; and to provide and utilize such laboratories for the conduct of important specialized investigations and services in space that cannot be effectively accomplished with other vehicles, particularly of the unmanned type.

Where are you going to spend this $2 million and with whom?

Mr. WYATT. There will be——

Mr. THOMAS. Let us put in pages 281, 282, and 283 at this point in the record.

(The pages referred to follow:)

ORBITING SPACE LABORATORIES

Fiscal year 1959	
Fiscal year 1960	$2,000,000

1. Objectives

To establish the scientific, technological, and civilian service requirements for orbiting space laboratories; to rationalize and refine the design, construction, and operating technology of orbiting space laboratories; and to provide and utilize such laboratories for the conduct of important specialized investigations and services in space that cannot be effectively accomplished with other vehicles, particularly of the unmanned type.

2. Justification

Current and planned programs for satellite experiments will provide a new wealth of scientific information of the physical environment of the earth. It has become clear, however, that there is a wide range of advanced scientific and technological investigations in space that can be more effectively performed with an orbiting space laboratory. Such laboratories will provide a stabilized platform in space with sufficient room, weight-carrying capacity, supporting instrumentation and equipment, and, as necessary, accommodations for scientists and technicians to perform more specialized and advanced operations than is possible with current types of space vehicles.

In particular, orbiting space laboratories will provide a capability for conducting advanced and extensive astronomical and cosmological investigations where the onboard operating and analytical faculties of man are advantageous. There are, similarly, other broad areas of scientific endeavor involving, for example, the influence of gravitation on biological processes and of high-energy particles on both organic and inorganic substances that warrant investigation and cannot be adequately simulated in earth laboratories. The space laboratory will also allow the assessment of man's capabilities, requirements, and limitations for performing more complex and extensive space missions.

Space laboratories will be required for the investigation and proof-testing of a host of vehicular components and operating techniques required for other advanced space vehicles. Of note are problems concerning the employment of optical and other critical components in a micrometeoritic environment, the influence of radiations on the structural behavior of special materials, the mechanism of vapor-liquid interfaces under zero-gravity as related to powerplant boilers and condensers, the feasibility of mechanical construction in space and the general performance evaluation of inertial platforms, referencing and navigation systems, scientific and operational sensors, space rendezvous systems, personnel equipment, and the like.

There are in addition a wide range of potentialities for the development and provision of important civilian services involving meteorology, communications, broadcasting, mapping, and special observation where the orbiting space laboratory will make vital contributions.

3. Program phasing

During the fiscal year 1960, a program will be initiated to advance the technology of the design, construction, and operation of orbiting space laboratories. Such a laboratory represents an important application of the manned satellite technology being developed in another program. In order to provide an early capability for advanced geophysical and biological experiments where earth stabilization and vehicle recovery is required, however, it is planned to initiate the development of internal modifications for a capsule of the type being developed in the manned satellite program for use as an unmanned orbiting space laboratory. The modifications will permit substitution of the experimental apparatus and associated instrumentation for the volume and weight normally required for manned operation. Initial development and construction of special subsystems and experimental apparatus for such a vehicle will also be initiated.

Concurrently, investigations will be undertaken to establish the design requirements for a more advanced orbiting space laboratory that will be large enough to accommodate two men together with appropriate scientific laboratory equipment and thereby permit conduct of a wider range of scientific studies in space.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Investigation of vehicular systems and operational techniques for unmanned laboratory experiment		$100,000
Study and development of instrumentation systems and techniques for space laboratories		200,000
Study and preliminary development of advanced space laboratories		600,000
Prototypes and operational hardware:		
Initial design and development of modifications to a manned satellite capsule		300,000
Initial development and construction of space laboratory apparatus and instrumentation systems		600,000
Supplies, equipment, repairs, and alterations		200,000
Total		2,000,000

Mr. THOMAS. Where?

Mr. SEIPERT. This will be by contract.

Mr. THOMAS. With whom?

Mr. SEIPERT. Again, we have not picked the contractors because we do not have the money. These are areas and estimates of the amounts of money required to make substantial studies in these areas.

TRACKING AND DATA ACQUISITION

Mr. THOMAS. Let us put in pages 284 and 285 in the record.

(The pages referred to follow:)

TRACKING AND DATA ACQUISITION

Fiscal year 1959	$3,300,000
Fiscal year 1960	11,500,000

1. Objectives

To maintain the operation of tracking and data acquisition facilities necessary to the overall space flight program; to develop improved tracking and data acquisition equipment.

2. Justification

The supporting effort on tracking and data acquisition is being planned to provide common operating facilities in these areas for as much of the varied workload as is practicable. In all cases, whether we consider a scientific program using satellites or sounding rockets, a space probe rocket, or a manned satellite experiment, there is a need for tracking units capable of delivering orbital data or position time histories, and telemetering receivers for data transfer. These devices must be properly coordinated by communications links and the data returned to a suitable computing center for rapid data reduction. Without such equipment there would be no point to most of the projected experiments, as there would be no data available for analysis. Each type of test generally brings with it special requirements on instrument performance, making it necessary to include in the design of the station equipment the greatest possible flexibility.

3. Program phasing

This program is intimately related to the construction and equipment portion of the budget as it is with that equipment that most of the operations are concerned. In the immediate future the data acquisition and tracking effort will be devoted to the continued operation of the existing IGY optical and radio interferometer networks. It is proposed to establish additional stations with supplemental fiscal year 1959 funds and with the regular fiscal year 1960 funds as discussed under the "Construction and equipment" section of the estimates. Operational contracts are planned under the "Research and development" appropriation title for a number of both the existing and the new stations. Support will be given to groups who have already participated in the IGY program so as to retain experienced personnel in station operations.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies: Studies relating to tracking methods, data reduction and analysis, methods of data transmission and telemetering	$300,000	$800,000
Prototypes and operational hardware: Telemetering receivers, tracking antennas, transmitters and receivers, readout devices and data recorders of new design	600,000	1,500,000
Operations and technical services: For the operation of the Smithsonian optical stations, the minitrack stations, the space probe receiving units, and shipborne facilities	2,000,000	7,500,000
Supplies, equipment, repairs, and alterations: Replacement parts, recording material, miscellaneous equipment, and minor alterations	400,000	1,700,000
Total	3,300,000	11,500,000

Mr. THOMAS. You are getting up into big money, $3.3 million last year against $11.5 million—

to maintain the operation of tracking and data acquisition facilities necessary to the overall space flight program; to develop improved tracking and data acquisition equipment.

Is this supplementary to the 11 stations you now have which you acquired from the IGY?

Dr. SILVERSTEIN. This is for the operation of the stations we have. We have some 12 optical stations and these 11 minitrack stations——

Mr. THOMAS. This is to maintain and operate, and there is no construction money?

Dr. SILVERSTEIN. This is not construction money.

Dr. DRYDEN. It should be pointed out that the amount in fiscal year 1959 is not the total cost of those stations.

Mr. THOMAS. What is this doing here? It looks as if that should be under the personnel section.

Mr. ULMER. This is for service-type contracts, Mr. Chairman. It does not involve personal services costs on the part of NASA It is a contract operation.

Dr. DRYDEN. For example, in a station in Peru——

Mr. THOMAS (reading):

> The supporting effort on tracking and data acquisition is being planned to provide common operating facilities in these areas for as much of the varied workload as is practicable.

This is not your construction program but you have a construction program, and this is for maintenance of facilities which you already have?

OPTICAL AND MINITRACK STATIONS

Dr. GLENNAN. And for the operation of the stations. We think it would be unwise to add to our payroll the number of people necessary to man these stations around the world.

Mr. THOMAS. How many stations are involved in the maintenance cost of $11.5 million?

Dr. SILVERSTEIN. Twelve optical stations and eleven minitrack stations, plus the Goldstone station.

Mr. THOMAS. Suppose we established additional stations, perhaps with supplemental fiscal year funds and in 1960, how many additional stations do you intend to build under your construction program?

That is four, as well as I remember, or five. That will give you a total of what, 16 or 17?

You are going to maintain them at a cost of $11.5 million a year; is that it?

Dr. SILVERSTEIN. Actually, if you added the optical stations, there are 12 optical and some 14 minitrack stations which is 26, plus 3 deep space antennas, which makes 29.

Mr. THOMAS. This $11.5 million is for the maintenance of those 29 stations?

Dr. GLENNAN. And their operation.

Mr. BOLAND. Who operates them?

Dr. DRYDEN. In the case of Peru, for example, we have a contract with the University of Peru to supply a large fraction of personnel. The station manager will be on our payroll. The pattern differs with the country.

In Australia, we will probably get cooperation whereby the Australians will bear a considerable fraction of the cost. It differs from country to country.

Mr. THOMAS. You had $3.3 million for 1959. Why the difference this year, $11.5 million?

Dr. DRYDEN. That is not the total cost. The money involved in IGY was financed through——

Mr. THOMAS. What was that figure on IGY?

Dr. GLENNAN. About $25 million.

Mr. THOMAS. Is this a firm figure of these contracts entered into, or an estimated figure? How many foreign countries are involved?

Dr. GLENNAN. Hobe Sound, Fla. (JUPITER); Curacao, Netherlands West Indies; Arequipa, Peru; Villa Dolores, Argentina; Olifantsfontein, South Africa; Cadiz, Spain; Shiraz, Iran; Naini-Tal, India; Woomera, Australia; Mitaka, Japan; Haleakala, Hawaii.

Mr. THOMAS. Is that a list of the locations you have there, Doctor?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. Please put that in the record.

(The list referred to follows:)

NASA OPTICAL TRACKING STATIONS (SMITHSONIAN ASTROPHYSICAL OBSERVATORY BAKER-NUNN CAMERAS)

Hobe Sound, Fla. (Jupiter)
Curaçao, Netherlands West Indies
Arequipa, Peru
Villa Dolores, Argentina
Olifantsfontein, South Africa
Cadiz, Spain
Shiraz, Iran
Naini-Tal, India
Woomera, Australia
Mitaka, Japan
Haleakala, T. H.

NASA DEEP SPACE PROBE TRACKING STATIONS (85 FEET)

Cape Canaveral
Puerto Rico
Goldstone, Calif. (85 feet)

Planned:
Woomera, Australia (85 feet)
South Africa (85 feet)
Bermuda (60 feet)

NASA MERCURY TRACKING STATIONS

Planned facilities:
Texas
Bermuda
Hawaii
Ships
Woomera
South Africa

NASA MINITRACK STATIONS

Present facilities:
Blossom Point, Md.
Antigua, W. I. F.
San Diego, Calif.
Quito, Ecuador
Lima, Peru
Antofagasta, Chile
Santiago, Chile
Woomera, Australia
Esselen Park, South Africa
Fort Stewart, Ga. (to be moved)
Havana, Cuba (to be moved)

Launch phase only:
Grand Turk

Planned for fiscal year 1959–60:
Newfoundland
Alaska
Spain
Fort Myer, Fla. (former Cuba station)
North Central United States (North Dakota)
Cape Canaveral (former Ga. station)

Mr. THOMAS. Do you have an approximate cost figure?

Dr. GLENNAN. I think we can provide that.

(The figures referred to follow:)

The cost of a Minitrack station is approximately $800,000, and the cost of a deep space probe station is on the order of $4,500,000.

Mr. THOMAS. Also those which have not been constructed.

How many are yet to be constructed, five or six?

Dr. SILVERSTEIN. There will be 7 and if you include the ones for the——

Mr. THOMAS. Australia?

Dr. SILVERSTEIN. Yes, sir. There is a South African station, a Bermuda station, and an Australian station which will have the large antennas and four minitrack stations to be added.

Mr. THOMAS. That is seven?

Dr. SILVERSTEIN. That will be seven.

Mr. THOMAS. How many are in existence now?

Dr. SILVERSTEIN. There are some 26 stations, including the optical stations.

Mr. THOMAS. Fourteen of them are IGY, or all of them?

Dr. SILVERSTEIN. There are 11 IGY's and 12 of Smithsonian optical stations. They are all IGY.

Mr. THOMAS. What is the total of IGY?

Dr. SILVERSTEIN. It would be 23.

Mr. THOMAS. Seven yet to be constructed?

Mr. OSTERTAG. Doctor, I was going to ask you, does your agency negotiate for the placement of these stations in foreign lands or has that already been done in most instances?

Dr. GLENNAN. This is done partially with the assistance of the State Department. Most of these operations were managed, or were manned, by the Army. In getting such contracts as we have in Peru and Chile, for instance, where the university and nonprofit organizations are doing this, these have been negotiated by State Department personnel with our assistance.

Mr. OSTERTAG. Have you run into any difficulty?

Dr. DRYDEN. Not as yet.

However, it might help to mention that these stations were put up under temporary agreements under the IGY. We have had the job of renewing the agreement or changing it to an agreement with us. They have not all been completed.

Mr. OSTERTAG. What is the length of the agreement in terms of time?

Dr. DRYDEN. The contracts we are negotiating usually provide for continuing cooperation.

Mr. THOMAS. Title to the property is in the foreign country? We are there by sufferance?

Dr. DRYDEN. This varies from situation to situation.

Mr. THOMAS. There is nothing you can do about it. You are lucky to be there.

Dr. DRYDEN. We have installations in many foreign countries.

Mr. THOMAS. That is right, just like your embassies. However, you are still at sufferance in the country. You are a guest of the country.

VEHICLE DEVELOPMENT

SCOUT SPACE FLIGHT VEHICLE

Let us put in pages 286, 287, and 288 in the record.

(The pages referred to follow:)

SCOUT SPACE FLIGHT VEHICLE

Fiscal year 1959	$6,048,000
Fiscal year 1960	2,000,000

1. Objectives

To develop a highly reliable, versatile, and inexpensive vehicle to extend capabilities for aerodynamic and space research.

2. Justification

A review of the various scientific experiments to be performed over the next several years has indicated the need for highly versatile, reliable, and inexpensive vehicles which can be launched with minimum facilities and which can be used to conduct a wide range of scientific experiments. These experiments include placing a variety of scientific payloads into 300–500 mile orbits, high-altitude probes, high-velocity reentry tests, advanced heating and ablation studies, and many similar type experiments. A study of the existing available vehicles indicates they are all complex and costly, and not fully optimized for the kind of mission and use described above.

The Scout vehicle is a natural extension and evolution of the multistaged solid-propellant rocket systems that the Langley Research Center has been developing over the last 10 years for high-velocity aerodynamic and reentry research studies. The solid-propellant rocket systems have demonstrated a very high degree of reliability in operation. The systems also combine simplified logistics and handling inherent in solids so that a reliable and inexpensive vehicle can be achieved.

The Scout vehicle consists of four solid rocket stages whose performance is representative of current advanced state-of-the-art solid propellants. It will have capabilities for launching payloads of 150–200 pound in circular orbit at 300 miles; for placing 100-pound payloads at about 5,000 mile altitudes; for achieving very high-velocity reentry (greater than 30,000 ft. per sec.); and for use in space target identification and guidance system evaluation.

The use of solid propellant motors, the simplicity of components, and the simplicity of launching and handling techniques will allow launching of the vehicle from a variety of sites including the NASA's Wallops Island Station. Handling and launching costs should be greatly reduced.

3. Program phasing

There are four major areas of development in the Scout: the propulsion system, the guidance system, the airframe, and the launcher. Contracts for the development of all four areas have been initiated in the fiscal year 1959. Fiscal year 1959 funds will be used for the major phases of development of these components including the procurement of eight sets of proplusion systems, four guidance systems, and airframes, and one launcher. Four guidance systems and four airframes will be procured with fiscal year 1960 funds.

It is anticipated that first vehicle evaluation flight test will be conducted in early 1960. Basic vehicle evaluation should be completed by summer of 1960 with the firing of three vehicles. The five remaining vehicles will be used with specific payloads to carry out useful research programs and to obtain data on vehicle performance.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Prototypes and operational hardware:		
Propulsion (includes delivery of 8 units)	$3,400,000	$200,000
Guidance and controls (includes 8 units)	850,000	300,000
Airframe and launcher (includes 8 airframes)	1,500,000	300,000
Operations and technical services: Vehicle flight evaluation		1,000,000
Supplies, equipment, repairs, and alterations: Vehicle and component evaluation	298,000	200,000
Total	6,048,000	2,000,000

Mr. THOMAS. Here we have a little "Buck Rogers steller space flight vehicle" in the amount of $2 million, and last year $6,048,000—

to develop a highly reliable, versatile, and inexpensive vehicle to extend capabilities for aerodynamic and space research.

Dr. DRYDEN. This is the wisest expenditure of money that you can think of. We have mentioned it now costs from $2.5 to $3.5 million to make a firing for a 20-pound weight. With this vehicle you can put up 150 pounds for about half a million dollars.

Mr. THOMAS. How high?

Dr. DRYDEN. 300-mile orbit.

Mr. THOMAS (reading):

The SCOUT vehicle is a natural extension and evolution of the multistaged solid-propellent rocket systems that the Langley Research Center has been developing over the last 10 years for high-velocity aerodynamic and reentry research studies.

Where is this work going to be done, near Wallops?

Dr. DRYDEN. Part at Wallops.

Mr. THOMAS (reading):

The solid propellant rocket systems have demonstrated a very high degree of reliability in operation. The systems also combine simplified logistics and handling inherent in solids so that a reliable and inexpensive vehicle can be achieved.

What is the cost per copy?

Dr. DRYDEN. About half a million dollars after they are developed.

Mr. THOMAS. Program phasing:

There are four major areas of development in the SCOUT: The propulsion system, the guidance system, the airframe, and the launcher.

How many have you got here for $3.4 million, four firings.

Dr. SILVERSTEIN. Eight vehicles in the program in the total of $6,048,000 for 1959 plus $2 million in 1960. This includes the development and launching and everything else, such as guidance development.

Mr. THOMAS. It is not half a million dollars apiece?

Dr. SILVERSTEIN. After they are developed. This includes the development of the guidance system for the SCOUT.

Mr. THOMAS. How many are you going to fire altogether? How many rockets down at Wallops during fiscal year 1960? You have quite a schedule there.

DELTA SPACE FLIGHT VEHICLE

Mr. THOMAS. Let us put in pages 289 and 290 in the record.

(The pages referred to follow:)

DELTA SPACE FLIGHT VEHICLE

Fiscal year 1959	$13,800,000
Fiscal year 1960	13,300,000

1. Objectives

To provide a reliable interim space flight vehicle for small payload satellites and very small payload space probes, replacing the present THOR-ABLE, JUNO II, JUPITER C, and VANGUARD vehicles.

2. Justification

Space projects to date have utilized vehicles that have been adapted from military ballistic missile boosters. While providing valuable interim service, most of these vehicles suffer from technical limitations that restrict their desirability for long-term application as space vehicles.

The DELTA space flight vehicle will replace the small-payload vehicles currently in use. It will be similar to the THOR-ABLE, but will have a coast-phase altitude control system, permitting higher injection altitudes. DELTA will be a three-stage vehicle in which the first stage will consist of a production THOR missile with the nose cone and guidance unit removed. The second stage will consist essentially of the VANGUARD second stage with an improved radio-inertial guidance system of higher accuracy. The third stage will be a solid propellent rocket motor developed for VANGUARD.

The DELTA vehicle will be applied to a number of satellites and space probe projects. It will have a payload capacity of 300 to 500 pounds for satellite applications and up to 75 pounds for probe shots to the vicinity of the moon. DELTA will be useful for both inclined and polar orbits and will be launched from either the Atlantic or the Pacific Missile Ranges as desired.

3. Program phasing

The DELTA program is divided into five parts: (1) Fabrication and test of the modified ABLE second stage; (2) procurement and test of the BTL guidance system; (3) modification of the THOR boosters; (4) integration of the complete DELTA; and (5) preparation and launch. Funding for this program,

including the procurement of 12 vehicles, will be initiated in fiscal year 1959 and continued in fiscal year 1960.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies: Integration and reliability studies	$500,000	
Prototypes and operational hardware: Thor boosters, 3d-stage rockets, vehicle design and manufacturing, and ground service equipment	13,300,000	$8,300,000
Operations and technical services: Range and launching services		5,000,000
Total	13,800,000	13,300,000

Mr. THOMAS. Here you have the DELTA space flight vehicle for fiscal year 1959 in the amount of $13.8 million, and $13.3 million in fiscal year 1960—

to provide a reliable interim space flight vehicle for small payload satellites and very small payload space probes, replacing the present THOR-ABLE, JUNO II, JUPITER C and VANGUARD vehicles.

Let us go on a little further:

The DELTA program is divided into five parts: (1) fabrication and test of the modified ABLE second stage; (2) procurement and test of the BTL guidance system; (3) modification of the THOR boosters; (4) intergration of the complete DELTA; and (5) preparation and launch. Funding for this program, including the procurement of 12 vehicles, will be initiated in fiscal year 1959 and continued in fiscal year 1960.

Where is this being made?

Dr. SILVERSTEIN. This is being made by the Douglas Co.

Mr. THOMAS. Have any of them been completed?

Dr. SILVERSTEIN. No, sir. The first of these vehicles will be coming in near the end of this year.

Mr. THOMAS. How many have you contracted for?

Dr. SILVERSTEIN. Twelve.

Mr. THOMAS. How long will it take to get the 12 and what is the total cost?

Dr. SILVERSTEIN. The schedule for completion of deliveries of these is about the end of 1961.

Mr. THOMAS. The total cost for the 12 will be what?

Dr. SILVERSTEIN. The total cost of the 12 will be about $36 million.

Mr. THOMAS. How do you differentiate the DELTA from some of the other vehicles now? What is the distinguishing characteristic? How high will it go? What is its thrust?

Dr. SILVERSTEIN. The DELTA has a thrust of about 150,000 pounds in the first stage. It has a very accurate guidance system in it.

This is one of the features. It has what is called a coast-phase altitude control system so we can put it very accurately into the prescribed orbit. None of our current vehicles has this capability. They might have a perigee of 200 miles and an apogee of 350.

Mr. THOMAS. How high will this go with a payload? How much is the payload?

Dr. SILVERSTEIN. This will take about a 200-pound payload or 250-pound payload into a 300-mile orbit. It will take a payload of about 80 pounds out past the moon.

Mr. THOMAS. This is one of your JUPITERS-VANGUARDS and an improvement on your old VANGUARD?

Dr. SILVERSTEIN. It is an improvement on the THOR-ABLE.

Mr. OSTERTAG. This is replacing that?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. This will cost $35 million before you are through?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. You are going to have 12 delivered and you get delivery when?

Dr. SILVERSTEIN. These are stretched out over a period of 2 years and 6 months.

Mr. THOMAS. Will the 13.8 million you have and this $13.3 million to be appropriated here do the job?

Dr. SILVERSTEIN. Mr. Chairman, I——

Mr. THOMAS. Will that be all the funds you need?

Dr. SILVERSTEIN. We will need an additional $8 million after 1960 for a total project cost of $35 million.

Mr. THOMAS. How firm is this figure of $13.3 million?

Dr. SILVERSTEIN. These figures given here are the contract numbers. In other words, we have entered into a contract for the purchase of these vehicles.

Mr. THOMAS. It is not for the specific sum of $13.3 million, is it?

Dr. SILVERSTEIN. We have entered into a contract with Douglas for the sum of some $24 million for 12 vehicles.

Mr. THOMAS. Will you overrun or will it be a lesser amount than the $24 million?

Dr. SILVERSTEIN. There may be an overrun. I doubt if it will be less.

Mr. THOMAS. That is always true, is it not? There is always an overrun?

Dr. GLENNAN. Mr. Chairman, I would point out that this vehicle gives us greater reliability and a better chance of doing the job we need to do than any we presently have. We went ahead under the pressure of public opinion——

Mr. THOMAS. Who made this contract, your crowd, or is it an inherited contract?

Dr. GLENNAN. NASA made this contract.

Mr. THOMAS. You have mentioned that pressure several times. Whose heavy hand was that? Where is all that pressure coming from? This committee has not been pressing you.

Dr. DRYDEN. Some of your colleagues.

Dr. GLENNAN. The law says that we are to maintain——

Mr. THOMAS. Who are the colleagues?

Dr. DRYDEN. Members of the Legislative Space Committees.

Mr. THOMAS. What have they been saying to you?

Dr. DRYDEN. That we ought to do even more than we are planning.

Dr. GLENNAN. "Why don't you want more money? Why aren't you asking for more money?"

We have tried to say that we are asking for the money that we think will allow us to do a reasonable job.

Mr. YATES. How do you know what the Russians are doing?

Dr. GLENNAN. We can only extrapolate from what they have done thus far. We can also take with, I think, a reasonable degree of credence, the published statements they have put out. They have just put out a publication which describes broadly what their program

is looking to. In the scientific realm, they have not spoken as loosely as they have in the political realm.

Mr. THOMAS. You mean they are pretty good scientists?

Dr. GLENNAN. Darn good scientists.

Mr. SEIPERT. Mr. Chairman, you made one observation on the probable overruns which I think we ought to make a comment on here.

In response to your questions, Dr. Silverstein has given you estimates based on actual contract negotiations and those are the figures that are included in here with no cushion or contingency or reserve in these budget figures for this overrun problem.

Mr. THOMAS. What do you mean by that?

Mr. SEIPERT. I mean that these are minimum figures. We believe that it will permit the work to carry forward on the schedule we have proposed, assuming we do not run into technical difficulties which inflate our costs.

Mr. THOMAS. You are laying the predicate here for an overrun; is that the purpose?

Mr. SEIPERT. We hope that we can manage this and have a much better experience on it than other folks in this field.

VEGA SPACE FLIGHT VEHICLE

Mr. THOMAS. Let us put in pages 291 and 292 in the record at this point.

(The pages referred to follow:)

VEGA SPACE FLIGHT VEHICLE

Fiscal year 1959	$22, 800, 000
Fiscal year 1960	42, 800, 000

1. Objectives

To provide the first general purpose vehicles in the national space vehicle program. The VEGA will be capable of a variety of civil space missions and will also be available as a backup vehicle for several military space missions.

2. Justification

The VEGA is intended to be used as either a two- or three-stage vehicle. Some missions, such as Project MERCURY, require only two stages while higher performance is required for lunar and space probes. The first stage will be a modified research and development ATLAS. (The modification will consist principally of changing the forward tank.) The second stage will carry liquid oxygen and kerosene as propellants and will use existing ATLAS tooling. The second stage will be powered by the VANGUARD first-stage engine, which will be modified to take advantage of altitude operation. The third stage, when used, will utilize storable propellants; this stage is currently under development by the Jet Propulsion Laboratory.

The first launch of the VEGA general-purpose vehicle is scheduled for the fall of 1960. Its planned payload capability of 5,000 pounds in a 300-mile earth orbit will permit the use of highly sophisticated communication and meteorological satellites. VEGA may also be used as a second vehicle in the Project MERCURY series to establish a manned orbiting space laboratory capable of supporting two men for several weeks. The VEGA vehicle will provide a capacity adequate to permit 800 pounds to be carried to the near vicinity of the moon. This payload should permit carrying sufficient instruments and transmitting equipment to investigate the moon's magnetic field and to determine whether or not the moon is surrounded by radiation belts similar to the Van Allen radiation belts surrounding the earth. The lunar surface radioactivity and the vestigial atmosphere could also be examined. It should also be possible to employ the VEGA to take high-resolution photographs of the hidden far side of the moon and by an electronic scanning tehcnique, to transmit the resulting

photographs to receiving stations on the earth. VEGA is the first vehicle suitable for attempting a close approach to Venus or Mars.

3. Program phasing

The VEGA program is divided into five parts: (1) development and testing of the modified VANGUARD engine; (2) modification of the ATLAS booster; (3) design and fabrication of the second stage; (4) integration of the VEGA vehicle; and (5) testing and launch. Funding for this program, including the procurement of eight vehicles, will be initiated in fiscal year 1959 and continued in fiscal year 1960.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies: Performance analyses and system integration	$2,000,000	$4,500,000
Prototypes and operational hardware: ATLAS boosters, 2d- and 3d-stage design and manufacture, and ground service equipment	20,800,000	38,300,000
Total	22,800,000	42,800,000

Mr. THOMAS. We are now getting into some more money.

This is the VEGA space flight vehicle and we have discussed this before with you, but it will not hurt to put all of this in the record again.

The amount is $22.8 million this year—

to provide the first general-purpose vehicles in the national space vehicle program. The VEGA will be capable of a variety of civil space missions and will also be available as a backup vehicle for several military space missions.

Tell us all about this one.

This is the one you are doing a part of at your Jet Propulsion Laboratory?

The VEGA is intended to be used as either a two- or three-stage vehicle. Some missions, such as Project MERCURY, require only two stages while higher performances is required for lunar and space probes. The first stage will be a modified R. & D. ATLAS. (The modification will consist principally of changing the forward tank.) The second stage will carry liquid oxygen and kerosene as propellants and will use existing ATLAS tooling. The second stage will be powered by the VANGUARD first-stage engine, which will be modified to take advantage of altitude operation. The third stage, when used, will utilize storable propellants; this stage is currently under development by the Jet Propulsion Laboratory.

The first launch of the VEGA general-purpose vehicle is scheduled for the fall of 1960. Its planned payload capability of 5,000 pounds in a 300-mile Earth orbit will permit the use of highly sophisticated communication and meteorological satellites—

What is the difference between this one and the one we had a while ago—DELTA?

Dr. GLENNAN. The difference between 250 and 5,000 pounds.

Mr. THOMAS. You have a cluster system here of three different stages, have you not?

Dr. GLENNAN. Yes, sir.

Mr. THOMAS. You can add to or take from, can you not?

Dr. GLENNAN. Basically you are using an ICBM as against the IRBM as the booster in the earlier one. The thrust is 150,000 pounds for the THOR and 365,000 for the ATLAS.

We put on top of it a stage which is proportionately matched for the first time to the ATLAS.

Mr. THOMAS. (reading):

VEGA may also be used as a second vehicle in the Project MERCURY series to establish a manned orbiting space laboratory capable of supporting two men for several weeks. The VEGA vehicle will provide a capacity adequate to permit 800 pounds to be carried to the near vicinity of the moon. This payload should permit carrying sufficient instruments and transmitting equipment to investigate the moon's magnetic field and to determine whether or not the moon is surrounded by radiation belts similar to the Van Allen radiation belts surrounding the earth.

You have another vehicle to go to the moon besides this one, have you not?

Dr. GLENNAN. The DELTA will take some small amount of instruments toward the moon; yes, sir.

Mr. THOMAS. What is the difference between DELTA and this one?

Is it just a question of size?

Dr. GLENNAN. Yes, sir.

Dr. SILVERSTEIN. This will take 10 times the weight.

Mr. THOMAS. More power?

Dr. SILVERSTEIN. More thrust.

Mr. THOMAS. How many of these do you have on order and when will you get them?

Dr. SILVERSTEIN. The first vehicle here is scheduled for August 1960.

Mr. THOMAS. How many do you have and who is making them for you?

Dr. SILVERSTEIN. There are eight vehicles in this program and they are being made by the Convair Corp.

Mr. THOMAS. Where are they located?

Dr. SILVERSTEIN. San Diego.

Mr. THOMAS. What is the total cost?

Dr. SILVERSTEIN. The total cost of the program will be in the order of $91 million expended over several years including the boosters and the firing vehicles.

Mr. THOMAS. What do you mean by "several years"? You had $22 million last year and you want $42.8 million this year?

Dr. SILVERSTEIN. That would be followed——

Mr. THOMAS. That is over $63 million and you will need another $30 million to get the job done?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. When will they all be delivered?

Dr. SILVERSTEIN. The last firing of this will be in 1962.

Mr. THOMAS. Is this an inherited contract or is this a contract made by NASA? When was it made?

Dr. SILVERSTEIN. This contract has been made recently by NASA—within the month.

Mr. THOMAS. How did you make the first stages, with transferred funds; or with appropriated funds?

Dr. SILVERSTEIN. It is hard to tell, sir, our "Research and development" appropriation contains both.

Mr. THOMAS. I was fixing to say that I would like to know how, if you can figure that.

Dr. SILVERSTEIN. The transferred and appropriated funds are merged into a single fund.

Dr. GLENNAN. I would like to point out that there is a great deal of development cost in this, Mr. Chairman; we would hope that these vehicles might be $5 million a copy after they are developed.

Mr. THOMAS. What is the nature of the contract? How much of the taxpayers' money is tied up here?

You have how many of them, eight?

Dr. SILVERSTEIN. Eight. The contract with Convair is only a part of the contract. We also have a separate contract with GE for the engines in the second stage.

Mr. THOMAS. GE?

Dr. SILVERSTEIN. They make the engines for the second stage.

Mr. THOMAS. General Electric?

Dr. SILVERSTEIN. Yes. Of course, we buy the boosters separately from the Air Force.

Mr. THOMAS. What fuel are you using in this vehicle?

Dr. SILVERSTEIN. Conventional fuel in the first two stages—liquid oxygen and kerosene. The top stage uses storable propellants, liquid oxygen and——

Mr. THOMAS. No solid propellants?

Dr. SILVERSTEIN. No, sir. There may be though in the payload we put on top of this. If we use this soft——

Mr. THOMAS. This will be like the old 1920 model Henry Ford put out when you get it up to 1955 and 1956, and then it will be different?

It will be powered by what? Nuclear power?

Dr. GLENNAN. Hydrogen-oxygen. That is the next item.

Mr. RHODES. I was going to ask you what your next generation will be.

Is your million-pound thrust engine ready?

Dr. GLENNAN. No, sir. The next one is the CENTAUR which has essentially the same configuration but uses liquid hydrogen with liquid oxygen.

Mr. RHODES. The first stage?

Dr. GLENNAN. The second stage.

Mr. THOMAS. What part of this $42.8 million is a firm figure?

Dr. SILVERSTEIN. These figures are all firm in the sense that they are the best estimates we can make at this time.

Mr. THOMAS. Cost-plus-fixed-fee?

Dr. SILVERSTEIN. Yes.

Mr. THOMAS. What is the amount of the fee?

Dr. SILVERSTEIN. I think it is less than 6½ percent.

Mr. THOMAS. Did you define the field that goes into the cost to make up this item?

Dr. SILVERSTEIN. Yes, sir. These contracts are handled by the same methods and with the same procurement regulations used by the military services.

Mr. THOMAS. Did the military make the contract for you?

Dr. SILVERSTEIN. We entered into the contract. At the contractors plants they will monitor the contracts for us as they monitor their own. For example, every plant in the country doing defense work has a group of inspectors set up and we will utilize the services of those inspectors.

CENTAUR SPACE FLIGHT VEHICLE

Mr. THOMAS. Let us put pages 293 and 294 in the record.
(The pages referred to follow:)

CENTAUR SPACE FLIGHT VEHICLE

Fiscal year 1959	
Fiscal year 1960	$41,000,000

1. Objectives

To develop a general-purpose space flight vehicle employing a high-energy fuel in fuel in an upper stage.

2. Justification

The technical direction of Project CENTAUR, initiated by ARPA in the fall of 1958, will be transferred to NASA on July 1, 1959. CENTAUR is a two-stage vehicle whose first stage is an R. & D. ATLAS missile of the type used in the VEGA program. The modified ATLAS vehicle consists of an operational ATLAS with the cone frustrum portion of the liquid oxygen tank replaced by a cylinder. Changing the forward end of this tank permits the upper stage to be the same diameter as the ATLAS vehicle. Between the lower and upper stages is a structural adapter that is attached permanently to the lower stage. The upper stage is mounted on top of the adapter which is jettisoned with the modified ATLAS booster. This high-energy stage is powered by two rocket engines. Sets of hydrogen peroxide rockets are utilized for upper stage attitude control during the coast period. The use of high-performance propellants permits a gain in payload weight of approximately 50 percent over VEGA for similar missions. Advanced missions, such as planetary probes, would require the use of a third stage.

The most important application for the CENTAUR vehicle will be to place a communication relay into an equatorial orbit having a period of 24 hours, to permit the satellite to hover over one spot on the earth's surface. The first six vehicles will be devoted to achieving this end. The early flights will be heavily instrumented and refinements dictated by the results of analysis of early test flight data will be incorporated into the later vehicle configurations. The final equatorial 24-hour circular orbit will require the second-stage engine to be fired a total of three times. The launch direction for the booster phase will be selected so that the early portion of a low-altitude parking orbit will cross the equator. At this point the second firing of the upper stage engines will increase the vehicle's velocity to place it into a transfer ellipse, the second stage being reoriented so that the third firing will provide the velocity for a circular orbit and a change in plane from the transfer ellipse to the equatorial plane. CENTAUR will be capable of a lunar soft landing and subsequent investigation of the lunar surface, atmosphere, and internal structure.

3. Program phasing

The first flight of CENTAUR is scheduled for 1961. Development of the vehicle and engine is in progress. The program is in five parts: (1) design, development, and fabrication of the engine; (2) modification of the ATLAS booster (3) design and fabrication of the second stage; (4) integration and testing of the complete CENTAUR; and (5) preparation and launching. Funding for this program, including the procurement of six vehicles, will be initiated in fiscal year 1959 and continued in fiscal year 1960.

4. Program costs

	Fiscal year 1959	Fiscal year 1960
Scientific and technical studies:		
Analyses and experiments to prove use of high-energy fuel		$2,500,000
Vehicle design and integration studies		1,500,000
Prototypes and operational hardware: ATLAS boosters, second-stage vehicle designs and manufacture, and ground service equipment		37,000,000
Total		41,000,000

Mr. THOMAS. What is this? Where and by whom is it made? You say it is—

to develop a general purpose space flight vehicle employing a high-energy fuel in an upper stage.

What is the difference between the CENTAUR and the VEGA?

Dr. SILVERSTEIN. The CENTAUR in the upper stages is the first vehicle that goes into our new technology.

Mr. THOMAS. You show a cost of $41 million. Is this a brand-new one?

Dr. SILVERSTEIN. This is a program started by the Department of Defense which we are talking over.

Mr. THOMAS. Initiated by ARPA and transferred to you?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. How much was transferred?

Dr. SILVERSTEIN. They transferred no funds. They funded it for $22 million in 1959 and we are taking it over at the beginning of the new fiscal year.

Mr. THOMAS. Who is doing the job for you?

Dr. SILVERSTEIN. This is, again, by Convair. They are the people who make the ATLAS and in the construction of these vehicles we are using the same domes that are used in the ATLAS.

Mr. THOMAS. Is this $41 million a firm figure? How many of them do you get?

Dr. SILVERSTEIN. There are six vehicles in this program that are delivered over a period of up through 1961–62.

Mr. THOMAS. This is an inherited contract?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. Is this $41 million a firm figure?

Dr. SILVERSTEIN. Yes, sir. It is an estimate for the next year.

Mr. THOMAS. Will there be an overrun here? How many units did you say, six?

Dr. SILVERSTEIN. Six; yes, sir.

Mr. THOMAS. Will it be an overrun?

Dr. SILVERSTEIN. I would not expect it, but there may be.

Dr. GLENNAN. This is a wholly new technology. This is a fallout now from some of the work done at Lewis Laboratory over the years on the use of hydrogen as a fuel, liquid hydrogen as a fuel. This is the first real step forward in the exotic new high-impulse propellants.

Mr. THOMAS. It will fire two rockets and they both use liquid hydrogen?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. You say that—

sets of hydrogen peroxide rockets are utilized for upper-stage altitude control during the coast period. The use of high-performance propellants permits a gain in payload weight of approximately 50 percent over VEGA for similar missions.

I thought you were trying to get away from these very exotic fuels on the theory that they were too costly.

However, is there no substitute for them when it comes to power? The state of the art had not developed any that produced the power that these exotic liquids do; is that it?

Dr. SILVERSTEIN. Yes, sir.

Mr. THOMAS. Let me read these three sentences:

The first flight of CENTAUR is scheduled for 1961. Development of the vehicle and engine is in progress. The program is in five parts: (1) design, development, and fabrication of the engine; (2) modification of the ATLAS booster; (3) design and fabrication of the second stage; (4) integration and testing of the complete CENTAUR; and (5) preparation and launching. Funding for this program, including the procurement of six vhicles will be initiated in fiscal year 1959 and continued in fiscal year 1960.

When will you be ready, not before 1961?

Dr. SILVERSTEIN. Late.

Mr. THOMAS. Do you think you will have them all by 1961?

Dr. SILVERSTEIN. They are staged to come through in intervals of about 2 months during 1961 and 1962.

Dr. GLENNAN. This will be a real step forward if we are successful. It is one we cannot ignore.

Mr. THOMAS. Gentlemen, let us come back at a quarter to one this afternoon.

AFTERNOON SESSION

CONSTRUCTION AND EQUIPMENT

Mr. THOMAS. Let us take a look at the construction and equipment program.

At this point in the record we shall insert the cover sheets which include pages 301 and 302 of the justifications.

(The pages referred to follows:)

Construction and equipment programs, fiscal years 1959 and 1960

	Fiscal year 1959		Fiscal year 1960 regular estimates
	Appropriated	Supplemental estimates	
Langley Research Center (Hampton, Va.):			
Alterations to the thermal structures tunnel			$745,000
Analytical computing equipment			2,645,000
Conversion of gust tunnel to noise research laboratory			315,000
Conversion of test cell to noise test facility			290,000
Heater and vacuum system for gas dynamics laboratory			585,000
Total	$11,350,000		4,580,000
Ames Research Center (Moffett Field, Calif.):			
Data reduction center			2,505,000
Mass transfer cooling and aerodynamics facility			4,050,000
Total	3,720,000		6,555,000
Lewis Research Center (Cleveland, Ohio):			
Ion and plasma jet facility			6,000,000
Zero-power reactor			605,000
In-pile loop			250,000
Land acquisition			5,000
Total	7,800,000		6,860,000
High-speed flight stations (Edwards, Calif.):			
Buildings additions			955,000
Analog computing equipment			350,000
Terminal guidance facility			1,500,000
Total			2,805,000
Space projects center (Beltsville, Md.):			
Central flight control and range operations building			3,300,000
Space sciences laboratory			6,000,000
Instrument construction and installation laboratory			3,700,000
Utility installations			1,000,000
Total	3,937,000		14,000,000
Pilotless aircraft station (Wallops Island, Va.)	21,193,000		
Jet propulsion laboratory (Pasadena, Calif.): New facilities, improvements to existing facilities, and approximately 70 acres of land		$9,000,000	
Pacific missile range (Point Arguello, Calif.): Launching facilities, including flight vehicle assembly and checkout facility with equipment for special experiments			3,000,000
Various locations:			
Global range tracking and communication facilities and equipment		12,050,000	10,000,000
Facilities for Rover program			2,000,000
Propulsion development facilities		3,200,000	8,000,000
Total		15,250,000	20,000,000
Total program	48,000,000	24,250,000	57,800,000

Mr. THOMAS. You have a supplemental construction request in the amount of $24,250,000 for 1959 against a regular budget request of $57,800,000 for 1960, and as well as I remember for 1959 the old NACA had a construction program of $23 million?

Mr. ULMER. Yes, sir; that is correct.

Mr. THOMAS. And your 1959 construction item for NASA was what? Was that figure $25 million?

Mr. ULMER. $25 million for NASA.

Mr. THOMAS. Well, you have some cash on hand; do you not? You have about $48 million in cash, and you want $24.25 million to supplement that for 1959 and then you want $57.8 million for 1960.

That summarizes that item.

For the Langley Research Center you are requesting $4.58 million; for the Ames Research Center you are requesting $6.55 million; for the Lewis Research Center you are requesting $6.86 million; for the High-Speed Flight Station you are requesting $2,805,000; you have a Space Projects Center where you are requestting $14 million; you have the Pilotless Aircraft Station at Wallops Island wherein you had $21,193,000 in the 1959 fiscal year.

Is $21,193,000 of your $24.25 million in the supplemental for Wallops?

Mr. ULMER. There is nothing in the supplemental for Wallops, Mr. Thomas.

Mr. THOMAS. Was there last year?

Mr. ULMER. Yes, sir.

Mr. THOMAS. What part of it has been spent?

Mr. ULMER. We have $2.4 million of that under contract.

Mr. THOMAS. You have a request here for your jet propulsion laboratory in the amount of $9 million under the supplemental estimates, and in your regular request there is nothing.

You have your Pacific missile range wherein you are requesting $3 million in your regular 1960 budget and then you have your various locations where you lump them together which include global range tracking and communication facilities and equipment in the amount of $12,050,000 under the supplemental estimates and $10 million in the regular fiscal year 1960 estimates; you have facilities for Rover program in the amount of $2 million in the regular 1960 estimates.

For the propulsion development facilities you have $3.2 million in the supplemental estimates and $8 million in the regular 1960 estimates.

That is a pretty good summary of it.

SUPPLEMENTAL CONSTRUCTION ESTIMATES FOR 1959

At this point in the record we shall insert pages 304 through 315 of the justifications.

(The pages referred to follow:)

RELOCATION AND EXPANSION OF FACILITIES

1. Description and justification

The Government-owned property and equipment of Jet Propulsion Laboratory (JPL) of the California Institute of Technology near Pasadena, Calif., was transferred to the NASA by Executive Order 10793, dated December 3, 1958. In the past, JPL has done outstanding research and development work in missile, satellite, and space probe fields through its contributions to the areas of solid propellant rockets, guidance systems, and electronic instrumentation, communication, and tracking systems. The NASA expects to rely heavily on JPL in the future for further advanced research and development in all of these areas in support of the national space program.

JPL was established before safety codes dealing with liquid and solid rocket propellants were established. Subsequent safety code standards have made most of the rocket test facilities at the Pasadena site nonconforming. At the present time all but 10 of the 92 facilities on the laboratory site are operating on safety waivers. These waivers make it illegal to modify the existing facilities to meet changing needs and thus severely restrict the potential future effectiveness of the laboratory. The effectiveness of the laboratory is also limited by inadequate vehicle assembly areas, guidance laboratories, and supporting facilities.

This project covers the modernization and expansion of facilities at JPL to provide for a strengthening of its research and development support of the NASA space program. Acquisition of a site of approximately 60 acres is required to

permit the relocation of various rocket test facilities and associated equipment to a nonhazardous location where safety code standards can be met. Another site acquisition of approximately 7 acres, currently under a rental agreement, is needed to provide for future expansion. Roads, water, and other utilities to service the new areas will be required. A new substation and transformer bank addition will be necessary to provide power for the proposed facilities.

In addition to the relocation of test facilities, the project includes the construction of a vehicle assembly building, the expansion of the guidance laboratory, and the modernization of several existing supporting facilities.

The present layout of the Jet Propulsion Laboratory and the proposed land and facility additions are shown on the site plan on the following page. Descriptions and justifications of the various items that comprise this project follow:

Land acquisition.—The present Jet Propulsion Laboratory comprises some 80 acres, of which approximately five are leased from the city of Pasadena. This existing acreage is shown as zone I on the site plan.

Acquisition of 60.37 acres (zone II): The Ordnance Department has secured a condemnation lease on approximately 60.37 acres of land north of and adjacent to the present JPL property line. This lease was taken to prevent the utilization of the land for a housing development which would have forced the suspension of all rocket test work work at JPL. This area is shown as zone II on the site plan. The land will be required for the relocation of existing rocket test facilities from zone I in order to permit their modification and expansion for advance research and development programs. The topography of the land is such that the proposed relocation can be accomplished to comply with all existing safety requirements.

Acquisition of 7.19 acres (zone III): There are another 7.19 acres of privately owned land contiguous to the southern boundary line of the existing laboratory. This land is designated zone III on the site plan. At present this area is under a lease which expires on July 1, 1959, and which the owner does not wish to renew. Other contiguous sites are rapidly being developed, and there is every reason to believe that this development will continue. Unless the proposed site is acquired it will undoubtedly be developed for other purposes, and further expansion of the Jet Propulsion Laboratory will become unduly expensive or be prohibited altogether. The proposed site is necessary to the future expansion of the laboratory, and its acquisition at this time is considered to be a prudent and economical investment.

Utilities.—Relocation area utilities: In order to provide access and utility services in zone II to the relocated facilities, it will be necessary to construct roads and extend and enlarge the utility systems now serving the existing laboratory facilities in zone I. The new land to be acquired is completely undeveloped, and is not adjacent to any public utility system.

It is planned to construct a central utilities plant to house the equipment and machinery required to operate and control the various utility systems. This building will be of frame and stucco construction with a total area of about 5,000 square feet including a small shop area.

New substation and transformer bank additions: The present substations and transformer bank are insufficient to provide power for the proposed facilities. Additions to the electrical system will be necessary to meet the new requirements. These additions will include a unit substation for transforming 16.5 kilovolts to 2.4 kilovolts for local distribution, feed lines to the substation from the existing high voltage supply, and an electrical distribution system to the new facilities.

Relocated test facilities.—A number of rocket test facilities and their associated equipment will be placed on the zone II site. These will replace existing facilities now located in zone I and operating under safety waivers and exemptions.

Solid propellant processing laboratory: This project includes a building of approximately 1,200 square feet of frame and plaster construction that will be used for shop and laboratory facilities; a building of approximately 4,000 square feet of reinforced concrete construction providing space for mixer, grinder, storage, and preparation rooms; and a mezzanine of approximately 1,200 square feet for necessary air conditioning and refrigeration equipment. Complete air conditioning, constant temperature, and humidity controls are essential for operation.

Solid propellant test cell and control building: This facility consists of two test cells (468 square feet each) and a control building (2,667 square feet). The test cells will be heavily reinforced concrete, earth-covered structures; a con-

crete pad with protective steel screen supported by steel frames will be provided at the firing end of each cell. Concrete mounting and thrust blocks will be designed to withstand 20,000 pounds of thrust. The control building will be of reinforced concrete and frame and stucco construction. The building will contain a control room, motor assembly shops, and laboratories.

Solid propellant test cell: A third test cell similar to the cells in the previous item will be constructed. It will include its own control building, but will utilize the laboratories provided in the previous item. The three test cells provided in these items will replace four test cells which are presently in violation of the safety code.

Solid propellant hazardous material storage magazine: This facility will provide for storage of hazardous solid propellant materials necessary for the development of rocket motors in the solid propellant engine program. The facility will consist of two reinforced concrete buildings with 16 individual earth-covered cells. The blowout wall on the road side of the buildings will be wood frame, dry wall type construction. Earth barricades will be required around this facility. This project will complete only a portion of the necessary storage facilities. The design will permit later addition of 24 additional storage cubicles.

Solid propellant chemistry processing laboratory: This facility is required for research and development on improved solid propellant materials. It will comprise approximately 2,000 square feet in a building of concrete block and reinforced concrete to house a propellant chemistry laboratory. In addition, there will be a 500 square foot enclosure housing grinder, blender, curing, surge, and charge rooms. This enclosure will have 3-foot reinforced walls for blast protection.

Liquid propellant test cell and control building: This facility consists of a twin mount, reinforced concrete test cell (462 square feet) and a 1½ story control building (4,158 square feet). The control building includes a central recording station, laboratory, security control room, and control room. A part of the building will be reinforced concrete, and the remainder frame and plaster construction. Some special lighting and air conditioning will be required in the control rooms, and 40 kilowatts of electrical power will be required.

Modernization of existing supporting facilities.—The expansion of several supporting facilities has not kept pace with the overall laboratory expansion. As a result, the technical effectiveness of the laboratory is being diminished by the use of marginal, and, in many cases, completely inadequate supporting facilities. In order to improve the efficiency and scope of operation of the laboratory, it is necessary to add to and modernize certain of these facilities.

Completion of guidance laboratory: The success of future satellite and space probe missions will be critically dependent upon the accuracy of the guidance system. The Jet Propulsion Laboratory has had considerable experience in the field of guidance systems for missiles and is expected to play a prominent role in the development of advanced systems for future space flight applications. The existing guidance laboratories at JPL are inadequate to conduct the necessary research and development. The proposed facility addition will provide the requisite laboratory space.

The facility will consist of a three-story wood and stucco structure totaling 42,366 square feet, fully air conditioned, and provided with the special electrical service needed in the development of guidance equipment. This building will house a complex of laboratories and offices. The increased area will accommodate the following functions: reliability research, solar battery research, component evaluation, information theory, infrared research, photo sensitivity research, inertial component laboratory, gyro research laboratory, optical component laboratory, transducer laboratory, tracking filter development, microwave component laboratory, new circuits laboratory, guidance computer laboratory, optical track laboratory, radio guidance, radio astronomy, stockrooms, service shops, and utility rooms.

Missile engineering building: The present missile engineering building was constructed in 1957 but was not completed to the known requirements. The proposed facilities will include an addition to the east end and a third floor addition to the central portion of the present building to provide 13,000 square feet of office space. Both additions will be of stud and stucco construction.

Plant services engineering building: The proposed addition to the present building will provide approximately 14,000 square feet of office space to relieve the present overcrowded conditions in a building presently housing the design, engineering, and supervisory personnel of the plant services department as well as supervisory personnel of the test mechanics services department.

Administrative services building: This facility will be an addition to the west end of the present building. It will provide for expansion of the property receiving department and of the proofing and accounting departments. This addition will also provide more workspace for the inspection and quality control departments, mail room, and shipping department. The addition will be of stud and stucco construction.

Carpenter shop building: This facility will be a two-story steel frame building with stud and stucco walls comprising an area of 8,500 square feet. It will replace the old carpenter shop which was recently torn down, and will provide space for the new carpenter shop and for lumber storage.

Plant services building: This facility will be an addition of approximately 10,000 square feet to the existing plant services building. It will be necessary to tear down parts of the present building for this construction, which will be of stud and stucco. The ground floor will contain shops for the electrical and mechanical groups of the plant service department. The second floor will contain offices for the electrical and mechanical department.

New supporting facilities.—Vehicle assembly building: At the present time, facilities for assembling complete vehicles at JPL are entirely inadequate. The present area is so congested that final checkout is done out of doors. The crowded conditions within the building and the inclement weather during outside operations seriously hamper the work. The proposed facility will move all operations indoors and will permit the assembly and checkout of several vehicles simultaneously. The proposed building consists of a vehicle assembly area of 18,700 square feet, an electrical test area of 15,400 square feet, mechanical and electrical supporting work areas of 20,300 square feet, and an upstairs office and laboratory area of 8,100 square feet. The assembly areas will have 50-foot ceilings of hangar-type construction, and other areas will be wood frame and plaster. Office areas and laboratories will have wood and linoleum floors and acoustical tile ceilings. Air conditioning is necessary for temperature and humidity control.

Reports and periodicals building: The proposed facility will be a Butler-type, prefabricated building of approximately 7,000 square feet to house the activities of the technical reports section until such time as a combined graphic arts building can be provided.

2. Cost estimate

LAND ACQUISITION

Acquisition of 60.37 acres (zone II)	$300,000	
Acquisition of 7.19 acres (zone III)	75,000	
Total, land acquisition		$375,000

UTILITIES

Relocation area utilities:		
Central utilities plant including boilers, water chillers, water treatment plant, air compressors, electrical switch gear, and miscellaneous items	$784,800	
Roads	500,000	
Drainage	104,000	
Fencing	36,000	
Steam distribution system	186,000	
Chilled water distribution system	210,000	
Water distribution system	216,000	
Sanitary sewer system	28,300	
Compressed air distribution system	29,600	
Gas distribution system	9,500	
Electrical substation system	384,000	
Street lighting	35,000	
Design, engineering, and contract administration services	252,000	
Total relocation area utilities		2,775,200

New substation and transformer bank addition:		
Unit substation, 2,500 kilovolt-amperes, 16.5 to 2.4 kilovolts, including voltage regulation	$100,000	
16.5-kilovolt feeder line to substation	10,000	
Tieline to existing system	20,000	
Underground feeds and ducts	45,000	
Total, new substation and transformer bank addition	175,000	
Total, utilities		$2,950,200

RELOCATED TEST FACILITIES

Solid-propellant processing laboratory:		
Building and equipment	$271,000	
Site preparation	5,400	
Paving	1,400	
Building utility services	14,600	
Barricades	16,000	
Retaining walls	24,000	
Design, engineering, and contract administration services	51,000	
Total, solid-propellant processing laboratory	383,400	
Solid-propellant test cell and control building:		
Instrumentation and laboratory building	43,500	
Test cell control room, motor assembly, and preparation shop building	72,600	
Test cells	48,600	
Retaining walls	14,000	
Paving	1,000	
Site preparation and excavation	65,500	
Barricades	2,800	
Utility connections and trenches	13,000	
Electrical substation	14,300	
Design, engineering, and contract administration services	28,100	
Total, solid-propellant test cell and control binding	303,400	
Solid propellant test cell:		
Test cell	35,100	
Control building	54,600	
Steel netting	2,300	
Retaining wall and slab	10,000	
Supporting facilities	12,000	
Instrumentation	35,000	
Miscellaneous equipment	15,000	
Total, solid-propellant test cell	164,000	
Solid-propellant hazardous storage magazine:		
Two buildings	125,000	
Barricades	16,000	
Utilities, including humidity and temperate controls	106,000	
Total, solid-propellant hazardous storage magazine	247,000	
Solid-propellant chemistry processing laboratory:		
Building	468,000	
Miscellaneous equipment	40,000	
Total, solid-propellant chemistry processing laboratory	508,000	

Liquid-propellent test cell and control building:		
Control building	$114,700	
Test cell	42,700	
Site preparation and excavation	65,550	
Building utilities	9,100	
Fuel tanks	12,000	
Electrical substation	18,200	
Nitrogen cascade	26,300	
Barricade	7,000	
Design, engineering, and contract administration services	30,500	
Total, liquid-propellent test cell and control building	326,000	
Total, relocated test facilities		$1,931,800

MODERIZATION OF EXISTING SUPPORTING FACILITIES

Completion of guidance laboratory:		
Building addition	$1,251,100	
Electrical utilities	43,000	
Sewer installation	4,800	
Water, gas, and air utilities	1,100	
Total, completion of guidance laboratory	1,300,000	
Missile engineering building:		
Addition to east end of existing building	285,000	
Third floor addition to central portion of existing building	100,000	
Equipment	100,000	
Total, missile engineering building	485,000	
Plant services engineering building	30,000	
Administration services building	120,000	
Carpenter shop building	170,000	
Plant services building	150,000	
Total, modernization of existing supporting facilities		2,255,000

NEW SUPPORTING FACILITIES

Vehicle assembly building:		
Building	$963,820	
Heating and air conditioning	180,000	
Paving	14,000	
Outside electrical utilities	85,000	
Outside utilities, general	16,990	
Design, engineering, and contract administration services	123,190	
Total, vehicle assembly building	1,383,000	
Reports and periodicals building	105,000	
Total, new supporting facilities		1,488,000
Total estimated cost		9,000,000

5. Construction schedule

Total estimated completion time: 14 months.

TRACKING FACILITIES

1. Description and justification

These funds requested in this project are required to provide the basic tracking, data acquisition, and communications capability that is essential for instrumentation coverage of satellites and space vehicles to be flown during the next 12 to 18 months. New tracking sites are to be established and some improvement will be made to existing equipment. For these purposes three general classes of equipment will be required as follows:

Extension and improvement of earth satellite electronic tracking network.—Experience gained during the initial operation of the minitrack electronic tracking stations in the IGY tracking satellite program has established the need for improving and augmenting the existing equipment to provide more reliable handling and transmission of tracking data and to provide increased capability for tracking of satellites in high inclination orbits. To accomplish these objectives it is planned to establish four new electronic tracking stations in Alaska, the United States, Newfoundland and Europe, and to install additional and improved equipment at some of the existing minitrack stations.

The equipment to be installed at each of the new stations will include antenna arrays, telemetry receiving equipment, communications equipment, command transmitters, and calibration equipment.

The improvements to the existing stations will include addition of real-time digital data read-out equipment, and additional antenna arrays for coverage of satellites in high inclination orbits. It is also necessary to shift the operation of all stations to a higher radio frequency since the 108-megacycle frequency presently used for tracking U.S. satellites is a temporary assignment. To make this frequency change will require reworking of all minitrack radio receiving equipment and antenna arrays.

Space probe tracking network.—The tracking and reception of telemetry data from space probes will require the provision of special high-gain, low-noise receiving systems at several points on the earth's surface. It is accordingly planned to provide a network of stations to support flight experiments of this type. One of these stations has been built at Goldstone, Calif. Funds are requested in this project to provide for the establishment of two additional stations, one in Australia and the other in South Africa. Each station will include large parabolic-antenna equipment to pick up the low-level signals, sensitive radio receiving equipment and electronic-hydraulic servo system for controlling the antenna. The amount requested will provide for initial site preparation and for basic equipment procurement.

Equipment for support of manned space vehicles.—Insertion tracking and guidance system: Detailed studies of the problems of recovering earth satellites, particularly manned systems, has established the desirability of north-east launchings from the Atlantic Missile Range site at Cape Canaveral with recoveries on the second and third orbits down the existing Atlantic Missile Range complex. Such operations will require the installation of precision radar acquisition, tracking communication, and associated systems at Bermuda to provide accurate trajectory information on the satellite after booster cutoff to establish that the satellite is in the desired orbit and to initiate abort action if unsatisfactory conditions exist. This station will also provide down-range data acquisition capability for long-range missiles and satellites launched from the NASA Station at Wallops Island, Va.

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

Initial reentry tracking and control system: Recovery of a manned satellite system on the second and third orbit down the Atlantic Missile Range will require precision tracking of the satellite during the reentry phase. It is, therefore, proposed to provide precision radar acquisition, tracking, communication,

and associated systems at Hawaii to provide initial impact-point prediction during the first phase of satellite reentry. This station will also provide a capability for emergency command control of retrorocket firing in the satellite in the event of malfunctioning of the present timer systems.

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

Midcourse reentry and landing tracking system: In order to provide adequate precision tracking of a reentering satellite between the areas in Western and Eastern United States now covered by existing range systems it will be necessary to provide precision radar acquisition, tracking, communications, and associated systems at a location in southern Texas. This station will be equipped for precision tracking of satellites launched northeast from Cape Canaveral on the first, second, and third orbits. This will also provide refinement of the impact-point prediction for satellite recovery on the second or third orbit down the Atlantic Missile Range. This station will also provide the critical tracking capability during the final stages of reentry and landing if land recovery of the satellite on the Texas plains during the first, second, or third orbit is required.

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

2. Cost estimate

Extension and improvement of satellite electronic tracking stations		$3,300,000
Equipment and facilities for 4 new stations, at $531,000	$2,124,000	
Antenna arrays	110,000	
Electronic equipment	346,000	
Site preparation and utilities	75,000	
Modification and improvement of existing electronic tracking stations	1,176,000	
Rework of station to change frequency: 12 stations, at $60,000	720,000	
Digital read-out equipment: 6 stations, at $26,000	156,000	
Additional antenna arrays: 6 stations, at $50,000	300,000	
Facilities for space probe tracking network		3,500,000
Initial site preparation, roads, utilities, housing (2 stations)	$1,900,000	
85-foot-diameter antenna systems (2)	950,000	
Radio receiving equipment (2)	460,000	
Antenna servocontrol systems (2)	190,000	
Equipment for support of manned space vehicles		5,250,000
Precision radar system for insertion tracking and guidance	$1,750,000	
Precision radar system for initial reentry tracking and control	1,750,000	
Precision radar system for midcourse and landing tracking	1,750,000	
Total estimated cost		12,050,000

RELOCATION AND EXPANSION OF FACILITIES FOR THE JET PROPULSION LABORATORY

Mr. THOMAS. Mr. Boland, did you have any questions at this point?

Mr. BOLAND. This concerns primarily the Jet Propulsion Laboratory; does it not?

Dr. DRYDEN. Yes, sir.

Mr. BOLAND. And this is at the California Institute of Technology at Pasadena?

Dr. DRYDEN. Yes, sir.

Mr. BOLAND. How many buildings are planned in this proposal? How many new buildings do you actually plan to have?

Mr. WYATT. I have not made a count of this, but this foldout map shows the new facilities.

Mr. ULMER. There will be only two new buildings. The balance of the money is required for modernization of existing facilities.

Mr. BOLAND. Do all of these hash marks and rectangles indicate new construction?

Mr. ULMER. They indicate items which are included in this estimate. A good number of them indicate facilities that will be moved to new locations where they will meet safety codes.

Mr. BOLAND. Is this going to be the total cost of the new construction? The new facilities will amount to only $9 million including the 70 acres of land?

Mr. ULMER. The $9 million includes the land, the modernization of existing facilities, the moving of certain facilities, and the construction of two new facilities.

Mr. BOLAND. Who presently owns the land?

Mr. ULMER. The Government.

Mr. BOLAND. Where did the Government get it? Did it acquire it some time ago?

Dr. DRYDEN. The Army acquired it.

Mr. SIEPERT. The land on which the present buildings are located is Government owned. There is a site which would need to be bought for these new facilities which is in private ownership at the moment.

Mr. WYATT. This aerial view of the map shows the following: This [indicating] is the existing plot. The land proposed to be bought is in this area to the top of the hill at this firebreak, and some land down here.

Mr. BOLAND. In other words, the terrain is similar to the terrain at Berkeley, Calif.; is it not?

Dr. DRYDEN. It is in a canyon.

Mr. WYATT. Yes; this is sloping land here, and here, it is fairly flat.

Then it goes up to a steeper level.

Dr. GLENNAN. The part above consists of a series of canyons into which can be placed these test cells, properly separated in order to get natural barriers of the earth and that type of thing.

Mr. THOMAS. I note you are going to spend $375,000 for this additional land.

Dr. DRYDEN. Yes. The existing site of 80 acres is already owned by the Government. The acquisition of about 70 additional acres is included in the project.

TRACKING FACILITIES

Mr. THOMAS. What about your tracking facilities? This is construction. You had a maintenance proposition this morning involving roughly $12 million. This is construction in the amount of $12,050,000. You have a small item here of $3 million for propulsion facilities. It is already in the record as to where you are going to locate your tracking facilities.

We will insert into the record at this point pages 316, 317, 318, and 319 of the justifications.

(The pages referred to follow:)

TRACKING FACILITIES

1. Description and justification

These funds requested in this project are required to provide the basic tracking, data acquisition, and communications capability that is essential for instrumentation coverage of satellites and space vehicles to be flown during the next 12 to 18 months. New tracking sites are to be established and some improvement will be made to existing equipment. For these purposes three general classes of equipment will be required as follows:

Extension and improvement of earth satellite electronic tracking network.—Experience gained during the initial operation of the minitrack electronic tracking stations in the IGY tracking satellite program has established the need for improving and augmenting the existing equipment to provide more reliable handling and transmission of tracking data and to provide increased capability for tracking of satellites in high inclination orbits. To accomplish these objectives it is planned to establish four new electronic tracking stations in Alaska, the United States, Newfoundland, and Europe, and to install additional and improved equipment at some of the existing minitrack stations.

The equipment to be installed at each of the new stations will include antenna arrays, telemetry receiving equipment, communications equipment, command transmitters, and calibration equipment.

The improvements to the existing stations will include addition of real-time digital data readout equipment, and additional antenna arrays for coverage of satellites in high inclination orbits. It is also necessary to shift the operation of all stations to a higher radio frequency since the 108-megacycle frequency presently used for tracking U.S. satellites is a temporary assignment. To make this frequency change will require reworking of all minitrack radio receiving equipment and antenna arrays.

Space probe tracking network.—The tracking and reception of telemetry data from space probes will require the provision of special high-gain, low-noise receiving systems at several points on the earth's surface. It is accordingly planned to provide a network of stations to support flight experiments of this type. One of these stations has been built at Goldstone, Calif. Funds are requested in this project to provide for the establishment of two additional stations, one in Australia and the other in South Africa. Each station will include large parabolic-antenna equipment to pick up the low-level signals, sensitive radio receiving equipment and electronic-hydraulic servosystem for controlling the antenna. The amount requested will provide for initial site preparation and for basic equipment procurement.

Equipment for support of manned space vehicles.—Insertion tracking and guidance system: Detailed studies of the problems of recovering earth satellites, particularly manned systems, has established the desirability of north-east launchings from the Atlantic Missile Range site at Cape Canaveral with recoveries on the second and third orbits down the existing Atlantic Missile Range complex. Such operations will require the installation of precision radar acquisition, tracking, communication, and associated systems at Bermuda to provide accurate trajectory information on the satellite after booster cutoff to establish that the satellite is in the desired orbit and to initiate abort action if unsatisfactory conditions exist. This station will also provide down range data acquisition capability for long-range missiles and satellites launched from the NASA Station at Wallops Island, Va.

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

Initial reentry tracking and control system:Recovery of a manned satellite system on the second and third orbit down the Atlantic missile range will require precision tracking of the satellite during the reentry phase. It is, therefore, proposed to provide precision radar acquisition, tracking, communication, and associated systems at Hawaii to provide initial impact point prediction during the first phase of satellite reentry. This station will also provide a capability for emergency command control of retrorocket firing in the satellite in the event of malfunctioning of the present timer systems.

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

Midcourse reentry and landing tracking system: In order to provide adequate precision tracking of a reentering satellite between the areas in western and eastern United States now covered by existing range systems it will be necessary to provide precision radar acquisition, tracking, communications, and associated systems at a location in southern Texas. This station will be equipped for precision tracking of satellites launched northeast from Cape Canaveral on the first, second, and third orbits. This will also provide refinement of the impact point prediction for satellite recovery on the second or third orbits down the Atlantic Missile Range. This station will also provide the critical tracking capability during the final stages of reentry and landing if land recovery of the satellite on the Texas plains during the first, second, or third orbit is required.

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

2. Cost estimate

Extension and improvement of satellite electronic tracking stations		$3,300,000
Equipment and facilities for 4 new stations at $531,000	$2,124,000	
Antenna arrays	$110,000	
Electronic equipment	346,000	
Site preparation and utilities	75,000	
Modification and improvement of existing electronic tracking stations	1,176,000	
Rework of station to change frequency: 12 stations at $60,000	$720,000	
Digital read-out equipment: 6 stations at $26,000	156,000	
Additional antenna arrays: 6 stations at $50,000	300,000	
Facilities for space probe tracking network		3,500,000
Initial site preparation, roads, utilities, housing (2 stations)	$1,900,000	
85 foot diameter antenna systems (2)	950,000	
Radio receiving equipment (2)	460,000	
Antenna servocontrol systems (2)	190,000	
Equipment for support of manned space vehicles		5,250,000
Precision radar system for insertion tracking and guidance	$1,750,000	
Precision radar system for initial reentry tracking and control	1,750,000	
Precision radar system for midcourse and landing tracking	1,750,000	
Total estimated cost		12,050,000

Mr. THOMAS. Your justifications state the following:

The funds requested here will permit initiation of the procurement of the basic precision radar system which requires a long leadtime for delivery.

Dr. DRYDEN. That comment refers only to the last $1.75 million in the table which follows. It is for the midcourse and landing tracking precision radar system.

Mr. THOMAS. Your justifications state:

The tracking and reception of telemetry data from space probes will require the provision of special high-gain, low-noise receiving systems at several points on the earth's surface. It is accordingly planned to provide a network of stations to support flight experiments of this type. One of these stations has been built at Goldstone, Calif. Funds are requested in this project to provide for the establishment of two additional stations, one in Australia and the other in South Africa. Each station will include large parabolic-antenna equipment to pick up the low-level signals, sensitive radio receiving equipment and electronic-hydraluic servo system for controlling the antenna.

There are four of them here, and they are all going to cost around $12 million.

What is it going to cost to maintain them? Is that a part of the——

Dr. DRYDEN. That is a part of the number we discussed earlier.

Mr. THOMAS. What part of this figure of $12.5 million is a firm figure?

Dr. DRYDEN. These are all based upon our best estimates. You will find a breakdown in our four new stations, at $531,000 apiece. They are essentially duplicating the equipment of the existing stations but at new locations.

Mr. THOMAS. And, of course, this money will be spent with foreign governments and for foreign labor, and so on?

Dr. DRYDEN. Some of it will, yes.

Mr. THOMAS. These estimates can vary 15 or 20 percent either way? Is that a fair statement?

Dr. DRYDEN. No; I do not think that is a fair statement.

Mr. THOMAS. Will you please give us a fair statement and I will accept it, 25 percent either way.

Dr. DRYDEN. No, sir; 5 percent or less.

Mr. THOMAS. Off the record.

(Discussion off the record.)

PROPULSION DEVELOPMENT FACILITIES

Mr. THOMAS. At this point in the record we shall insert pages 320 and 321 of the justifications.

(The pages referred to follow:)

PROPULSION DEVELOPMENT FACILITIES

1. Description and justification

The capability of placing large payload satellites in earth orbits or of operating advanced scientific manned and unmanned payloads to the near planets is dependent on the availability of rocket boosters developing over 1 million pounds of thrust. In order to obtain these thrusts with a high reliability, the NASA is developing, under contract, a single chamber rocket engine having a nominal thrust of 1 million pounds. This engine development is expected to be complete in about 4 years.

The development of this powerplant, some four times the size of its largest forerunner, calls for extensive and expensive facilities for its fabrication and testing. The engine development program has been planned to make the utmost use of facilities, such as the Air Force large test stands at Edwards Air Force Base, which exist or are currently being built for other programs. Operated by Rocketdyne, a division of North American Aviation, and its engine-development contractor, these stands will satisfy the basic test stand requirements of the NASA engine program. Similarly, use of machine tools installed at Rocketdyne by the Air Force for the ballistic missile development program will be used to obviate the need for large expenditures under the NASA program for new machine tools. However, some additional facilities must be acquired for the million-pound-engine development.

In the fiscal year 1959 it will be necessary to provide funds for the adaptation of and additions to facilities presently existing at the test sites the contractor will use in the NASA program. Specifically, facilities are needed for development work on the turbo pump, gas generator, thrust chamber, controls, and other items. Proper development of this overall engine requires that each of the components be developed independently and that development must be started on all of the components soon if the final engine development is to be completed within the allotted time. Testing of the completed engine will be on stands provided by the Air Force at Edwards Air Force Base.

Gas generator and control facilities: A gas generator is used to supply high-temperature, high-pressure gas to power the 65,000-horsepower turbopump which pumps the liquid propellants into the engine thrust chamber. Additional capacity for development and testing of a gas generator of this size and for controlling

the rate of propellant flow will be provided so that these components can be built and tested independently of the other components. The facilities which will be modified to provide this additional capacity are located at the Rocketdyne test site in the Santa Susanna Mountains above the Rocketdyne plant at Canoga Park, Calif.

Turbopump test facilities: The turbopump consists of three elements—a turbine and two pumps, one for the oxidant and one for the fuel. Each of these three components must be tested independently to evaluate properly the performance of each. The complete assembly must then be tested and evaluated. A means has been devised to accomplish these tests by adding to an existing Rocketdyne facility at Santa Susanna.

Laboratory and manufacturing equipment: The engine is being designed and parts are to be fabricated at the contractor's plant at Canoga Park. Additions to laboratory equipment, manufacturing support equipment, and modifications to production facilities procured by the Air Force to accommodate parts of the size of this engine are required. The funds NASA is requesting will cover such items as specialized instrumentation; special test consoles; larger tanks, plumbing, and valving; larger steel mounting frames; and special safety equipment.

Thrust chamber and engine test stand: In the fiscal year 1959 funds must be provided to complete the modifications and additions to the Air Force thrust chamber stand 2–A and engine stand 1–A at the Edwards Air Force Base, Calif. Also required for fiscal year 1959 funding are the longest leadtime items to adapt to this program the engine stand 1–B which will have two firing positions. The Air Force has pending a request for authority to build stand 1–B with $4 million of fiscal year 1959 funds.

2. Cost estimate

Rocketdyne, Santa Susanna:	
Gas generator and control facilities	$471,000
Turbopump test facilities	563,000
Rocketdyne, Canoga Park: Laboratory and manufacturing equipment	366,000
Total, contractor sites	1,400,000
Edwards Air Force Base:	
Stand 2–A	219,300
Stand 1–A	944,500
Stand 1–B	636,200
Total, Edwards Air Force Base	1,800,000
Total estimated cost	3,200,000

Mr. THOMAS. Your description and justification states as follows:

The capability of placing large payload satellites in earth orbits or of operating advanced scientific manned and unmanned payloads to the near planets is dependent on the availability of rocket boosters developing over 1 million pounds of thrust. In order to obtain these thrusts with a high reliability the NASA is developing, under contract, a single chamber rocket engine having a nominal thrust of 1 million pounds. This engine development is expected to be completed in about 4 years.

We have already gone into that. That is the Vega program; is it not?

Dr. DRYDEN. The capital items have to be spelled out separately under the law.

Mr. THOMAS. Well, let us read the second paragraph. I have every word of it underlined. It must be important.

The development of this powerplant, some four times the size of its largest forerunner, calls for extensive and expensive facilities for its fabrication and testing.

We went into that in great detail this morning; did we not?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. Why do you set out here an item of $3.2 million when you had this whole program of $42 million this morning?

Dr. DRYDEN. The law requires that capital improvements over $250,000 be authorized separately. We request such items in the "Construction and equipment" appropriation.

Mr. THOMAS. What is this right here?

Dr. DRYDEN. This is a construction project covering items of capital nature. It covers modifications and additions to some Air Force-owned facilities, and some facilities at a contractor's plant.

Mr. THOMAS. That figure of $42.5 million is not complete, then. It is around $46 million?

Mr. WYATT. No, sir. This construction item will provide facilities in connection with the 1-million-pound thrust engine contract which is in the 1960 budget for $30.2 million.

Mr. THOMAS. Well, I just missed it by $15 million.

What is that error among friends?

Dr. GLENNAN. Not much, if it is on the right side.

CONSTRUCTION AND EQUIPMENT PROGRAM FOR 1960

Mr. THOMAS. Will someone answer my longhand notes over here: Are you spending money on obsolete equipment under alterations to the tune of $4.58 million?

Mr. ABBOTT. No, sir; we are not.

COMPUTING EQUIPMENT

Mr. THOMAS. What about your computing equipment? You do not have your new ones installed yet, and here is another $2.6 million.

Mr. ABBOTT. This is to provide the computing equipment that we need for the very extensive simulation work that needs to be done.

Mr. THOMAS. The equipment that you are installing now will not get the job done?

Mr. ABBOTT. No, sir; it will not.

Dr. DRYDEN. I wonder if we are not confused? Last year we had the data reduction center at Langley and this is a similar installation at Ames.

Mr. ULMER. I think Mr. Thomas is talking about the second Langley item for computing equipment.

Mr. THOMAS. $2,645,000.

Mr. ULMER. Yes, sir.

Mr. ABBOTT. The Langley item is for the procurement of additional computing equipment which will be housed in the computing center building now under construction.

Mr. THOMAS. But you had some computers in it; did you not?

Mr. ABBOTT. Yes, sir.

Mr. THOMAS. Do you have them installed yet?

Mr. ABBOTT. They are not installed in the new building yet.

Mr. THOMAS. The question we are raising now is this: What about this computing equipment now in the amount of $2.6 million?

Mr. ABBOTT. This is to enable——

Mr. THOMAS. That is over and above the amount which you had for last year?

Mr. ABBOTT. Yes, sir; this is over and above it.

Mr. THOMAS. At the same location?

Mr. ABBOTT. Yes, sir.

Mr. THOMAS. What is the difference between the two?

Mr. ABBOTT. The computing equipment which we have now in the new building is for data reduction and for analytical computing. This equipment will be primarily for simulation work.

Mr. THOMAS. In other words, running your tests instead of having to sit down and figure it all out?

Mr. ABBOTT. Yes, sir. We can simulate with this equipment the flight conditions in advanced aircraft, missiles, and spacecraft.

Mr. THOMAS. What are you going to do at Ames? You have $6,860,000 for that project.

Mr. ABBOTT. At Ames the first item is for a data reduction center which is of the same type as the one you approved for us at Langley. In other words, the needs are the same there.

Mr. THOMAS. How firm are these figures for this equipment? Are you renting these? You are not buying them, of course?

Mr. ABBOTT. We are renting equipment at all research centers. In the Ames Reduction Center project there is a figure of approximately $660,000 for the purchase of machinery which we cannot rent.

MASS TRANSFER COOLING FACILITY

Mr. THOMAS. What about this cooling facility here? Is this a firm figure? Is this a modification of an existing one, or new equipment?

Mr. ABBOTT. This is new equipment to enable us to do things that we now cannot do.

Mr. THOMAS. Will you contract for its construction or are you building it yourself?

Mr. ABBOTT. This will be built under contract.

Mr. THOMAS. Is it a firm figure? Is it to be built on a cost-plus basis, or what?

Mr. ULMER. Most of these structures will probably be advertised on a competitive basis. We think they are very good estimates. They were prepared by men who have had many years' experience in doing this type of work.

LEWIS RESEARCH CENTER

Mr. THOMAS. You have $6.8 million at the Lewis Laboratory including $6 million for jet facilities.

What is that reactor in the amount of $605,000?

Mr. ABBOTT. The first item of $6 million is essentially a very large vacuum tank to permit us to duplicate on the ground the vacuum conditions in space in order to allow us to study electrical rocket propulsion systems on the ground.

It also includes housing the associated electronics and other equipment.

Mr. THOMAS. Will this be constructed by your own people or will you contract for this?

Mr. ABBOTT. This will be contracted for.

Mr. THOMAS. This is not an on-the-shelf item by any means; is it?

Mr. ABBOTT. No, sir.

Mr. THOMAS. Who is your contractor?

Mr. ABBOTT. There is no contractor yet. The contracts would be let primarily as a result of competitive bids, after the funds are provided.

Mr. THOMAS. Will it be in the form of one contract or do you break it down into several contracts?

Mr. ABBOTT. We customarily break it down into a number of contracts. The people who are particularly qualified to do certain classes of work will receive various portions of the contract.

LAND ACQUISITION

Mr. THOMAS. What about your land acquisition? I thought we had already bought the land at Lewis.

Mr. ULMER. On page 362 of the justifications I believe we have described the various areas of land that have been provided for us and the two small areas that we are attempting to get authorization for this year.

Mr. THOMAS. Where are the small pieces of land which you propose to buy?

Mr. ULMER. The area marked "B" which is close to the laboratory and the small area which is marked "leased to CAA."

Mr. THOMAS. Where, on that map, is the airport?

Mr. ULMER. It is above the laboratory area.

Mr. THOMAS. Where is this piece of land? Is it adjacent to the airport?

Mr. ULMER. It is in the gully right back of our laboratory. You gave us an area beyond the laboratory.

Mr. THOMAS. Out in front; was it not, and to the left?

Mr. ULMER. To the left of the administration building; yes.

Mr. THOMAS. How many acres was that? The only mistake we made on it is that we should have bought it 7 or 8 or 10 years ago in order to save a little money.

Mr. SIEPERT. 115 acres.

Mr. THOMAS. What did that land cost? Did it cost $2,500 an acre?

Mr. ULMER. About $2,500 per acre, yes. We are talking now about a small area of park land here.

Mr. THOMAS. How many acres?

Mr. ULMER. 25.

Mr. THOMAS. You are going to pay how much for it?

Mr. ULMER. $5,000.

Mr. THOMAS. How much is that an acre?

Mr. ULMER. $200. It is not worth very much, actually. It is a very large gully, and the Rocky River runs through it. It is not usable for any commercial or private purpose.

HIGH SPEED FLIGHT STATION (EDWARDS, CALIF.)

Mr. THOMAS. For Edwards you have a request in the amount of $2,805,000. For building additions you are requesting the sum of $955,000, for analog computing equipment you are requesting the sum of $350,000, and for terminal guidance facilities you are requesting the sum of $1.5 million.

Mr. ABBOTT. Yes, sir.

Mr. THOMAS. How firm is this request?

Mr. ABBOTT. I think those figures are quite firm, sir.

Mr. THOMAS. Doctor, I want you to try to pick out one here where you are going to have a surplus. Can you not find one where it is not too firm and where you have a little surplus?

Dr. DRYDEN. Mr. Chairman, this list when we received it from the laboratories started at about two or three times the amount of money and about two or three times as long.

We boiled it down and then the Bureau of the Budget boiled it down some more, and this is what is left.

LAUNCHING FACILITIES, PACIFIC MISSILE RANGE

Mr. THOMAS. What about your launching range? Where is it? Will it be located at Mugu?

Dr. DRYDEN. No, sir; this item is for Point Arguello.

Mr. THOMAS. Who has Point Mugu? Is that the Navy?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. How far it is down from Mugu?

Dr. DRYDEN. This is north of Mugu about 70 miles.

Mr. THOMAS. On up the coast?

Dr. DRYDEN. Yes, sir. It is just below Vandenberg Air Force Base. This is for the Pacific Missile Range and is to provide a launching pad and blockhouses for THOR boosters.

EQUIPMENT AND INSTRUMENTATION FOR GLOBAL RANGES

Mr. THOMAS. At this point in the record we shall insert pages 389, 390, 391, and 392 of the justifications.

(The pages referred to follow:)

EQUIPMENT AND INSTRUMENTATION FOR GLOBAL RANGES

1. Description and justification

These funds will be needed to continue the improvement of satellite and space vehicle tracking stations for which funds were requested in the fiscal year 1959 supplemental estimate and to provide additional instrumentation facilities specifically required to support manned satellite experiments.

Improvement of existing electronic and optical tracking stations.—To provide the tracking, data acquisition, and the communication facilities needed to support the more complicated satellite experiments planned for the period beginning 1 to 2 years from now, further modification and improvement of the electronic and optical tracking networks will be required. The funds requested in this project will provide for a continuation of the antenna and data read-out equipment improvement which was begun with fiscal year 1959 funds. Higher capacity telemetry equipment will also be installed at some of the stations to handle a larger number of satellite programs, and to service a wider bandwidth telemetry data reception.

In addition, the electronic tracking facilities will be supplemented by the provision of improved optical tracking equipment to provide a very high precision tracking data needed for geodetic, navigation, and relativistic satellite experiments.

Data acquisition station on Bermuda.—The project includes funds to provide for the establishment of high-gain automatic tracking antenna and its associated radio receiving, recording, and control equipment on Bermuda. This equipment will serve multiple purposes which include reception of telemetry data from rocket and satellite vehicles launched from Wallops Island and Cape Canaveral, acquisition of telemetry data from space vehicles in orbit, and supplementary tracking of space probes.

Facilities for support of manned space vehicle.—Control center systems: Proper execution of the various functions required on a global basis for the

launching, flight, reentry, and recovery of a manned satellite system will make necessary the provision of a suitable center for the coordination and control of the complete operation. It is proposed to supplement existing equipment systems to accomplish these functions.

The funds requested herein will be required to provide a voice link to the manned satellite, and modifications to existing equipment for command functions to the satellite. Necessary data transmission terminal equipment with coordinate converters, computers, data-recording apparatus, display systems, and control devices would also be provided.

Data acquisition systems: Scientific and operational data generated in a satellite during launching, orbiting flight, and recovery, must be relayed to ground stations for reduction, analysis, and control of subsequent operations.

Funds are included to provide such data acquisition systems for five ground stations and seven shipboard installations, and to supplement existing equipment at five additional ground stations. The systems will include antenna networks, telemetry receivers, data-handling equipment, and display devices. Installation will be made at the primary ground stations in the manned satellite network.

Extension of data transmission, communication, and command systems: In order to close major gaps in the ability to coordinate data acquisition and control functions in the network of ground stations for manned satellite operations that were started in the fiscal year 1959, additional equipment will be required at various stations to provide adequate data transmission, voice communication, with other ground stations and the satellite, and command control of satellite functions.

Funds are requested to provide supplementary high-frequency single side-band or ionospheric scatter systems for surface communications, high-frequency and very high frequency transmitters and receivers for voice communications with the satellite, command interrogation systems, and associated antenna and data-handling equipment.

2. Cost estimate

Improvement of existing electronic and optical tracking stations		$1,500,000
Optical tracking equipment	$600,000	
Telemetry receiving and recording equipment	150,000	
Antenna arrays: 5 stations, at $50,000	250,000	
Digital data read-out equipment: 6 stations, at $26,000	156,000	
Instrument buildings: 11 stations, at $25,000	275,000	
Test and calibration equipment	69,000	
Data acquisition station on Bermuda		1,355,000
Site preparation and utilities	$335,000	
Basic tracking antenna system	650,000	
Telemetry receiving and recording system	205,000	
Test equipment and spares	165,000	
Facilities for support of manned space vehicles		7,145,000
Control center systems	$1,045,000	
Voice link to satellite	$100,000	
Command system modifications	50,000	
Data handling systems	490,000	
Computing facilities	305,000	
Data display equipment	100,000	
Data acquisition system	4,100,000	
Antenna, telemetry receivers, and data handling and display systems for 5 ground stations	$1,500,000	
Antenna, telemetry receivers, and data handling and display systems for 7 shipboard installations	2,100,000	
Modifications and additions to telemetry systems at 5 existing ground stations	500,000	

Facilities for support of manned space vehicles—Continued		
Extension of data transmission, communication, and command systems		$2,000,000
Surface communication systems	$1,000,000	
Satellite voice links and command control system	700,000	
Auxiliary equipment	300,000	
Total estimated cost		$10,000,000

Mr. THOMAS. This is your program of equipment and instrumentation for global ranges and includes a data acquisition station on Bermuda. Your justification states as follows:

> The project includes funds to provide for the establishment of high-gain automatic tracking antenna and its associated radio receiving, recording, and control equipment on Bermuda. This equipment will serve multiple purposes which include reception of telemetry data from rocket and satellite vehicles launched from Wallops Island and Cape Canaveral, acquisition of telemetry data from space vehicles in orbit, and supplementary tracking of space probes.
>
> The funds requested herein will be required to provide a voice link to the manned satellite, and modifications to existing equipment for command functions to the satellite.

For continuation of these activities, how much are you going to put in for this data acquisition? Is that where you set up the $10 million back over here?

Mr. ULMER. The total of the whole project is on page——

Mr. THOMAS. "Equipment and instrumentation" was $10 million, the facilities for ROVER $2 million, and your proposal for propulsion development facilities is for $8 million. You have $20 million.

Can you break down this data acquisition as to where it is going to be located, the nature of it, and the cost?

I believe it is in the table at page 391.

Dr. DRYDEN. That is right.

Dr. SILVERSTEIN. I was going to call your attention to that.

Mr. THOMAS. From whom do you buy this equipment? Who manufactures it?

Dr. SILVERSTEIN. The electronic companies such as the Radio Corp. of America.

Mr. THOMAS. Is not Boston a fastly developing area along this line? It is a center for fine electronics equipment. Is not there a tremendous business in electronics in Boston?

Dr. DRYDEN. In the northeastern area generally.

Mr. THOMAS. Are these firm figures for five stations at $250,000?

Mr. DRYDEN. Yes, sir.

Mr. THOMAS. That is $50,000 each.

I note you have digital data readout equipment at six stations at $26,000 each.

Are these firm figures?

Dr. SILVERSTEIN. Very firm, sir.

Mr. THOMAS. Then I note you have instrument buildings at 11 stations at $25,000 each.

Are not these IGY stations already equipped, gentlemen?

Dr. SILVERSTEIN. These stations are being modified—some of the existing stations—for several purposes. One is to provide an ability

to take care of our polar firings. We have to turn our antennas around for that purpose; and secondly, some of the equipment that is there——

Mr. THOMAS. This is to purchase a new one, though. It does not say anything about a modification. It mentions site preparation and utilities. This is a new situation down at Bermuda where your site preparation and utilities are estimated to cost $335,000.

What are you paying for your land, and how much land do you plan to acquire for the sum of $335,000? That is a lot of money.

Dr. SILVERSTEIN. This, of course, will be on an existing MATS airport.

Mr. THOMAS. Certainly you do not need $335,000 for site preparation and utilities.

Dr. DRYDEN. There are four antenna systems which are spaced about 500 feet apart.

Mr. THOMAS. Where is your tracking antenna system which is estimated to cost $650,000? That is the cost of the hardware itself?

Dr. DRYDEN. Here [indicating] is what we are talking about. The antenna is that thing at the lower right. It is an elevated structure.

Mr. THOMAS. Doctor, what I am talking about is that you have site preparation and utilities listed at $335,000.

Dr. DRYDEN. It is a site for these four antennas.

Mr. THOMAS. Your tracking system is $650,000. Is that a firm figure?

Then you have your telemetry receiving and recording system at $205,000 and you have test equipment and spares at $165,000.

What are your spares?

Dr. SILVERSTEIN. You have to have spares available at these many stations because when a satellite is overhead and something burns out you have to have something to put in its place.

Mr. THOMAS. You have facilities to support manned space vehicles in the amount of $7,145,000 and included in that is voice link to satellite in the amount of $100,000, command system modifications in the amount of $50,000, data handling systems in the amount of $490,000, computing facilities in the amount of $305,000, and data display equipment in the amount of $100,000.

Mr. GLENNAN. This is all a part of getting this man back and understanding what he has done up there.

FACILITIES FOR ROVER PROGRAM

Mr. THOMAS. At this point in the record we will insert pages 393 and 394 of the justifications.

(The pages referred to follow:)

FACILITIES FOR ROVER PROGRAM

1. Description and justification

Nuclear heat transfer rockets in which a low molecular weight gas is heated to high temperature in a nuclear reactor and then expanded through a jet nozzle to produce thrust, offer large performance gains over chemical rocket systems. The low molecular weight of the discharge gas combined with the high gas temperature in the reactor permit the attainment of impulses for the nuclear system that are approximately twice as high for the nuclear rocket as for the chemical system. This high impulse gives the nuclear rocket the potential of delivering a large payload into an earth orbit with a single-stage machine whereas the chemical rocket might require at least two and probably three stages. The

ROVER program now in process is aimed at the development of small, high temperature, high-power reactors for use in high thrust booster rockets. The NASA responsibility in this program is concerned primarily with the development of a propellent feed system for the KIWI–B reactor tests. A multistage pump is being developed for this purpose.

At the present time, the AEC Nevada test site has facilities for testing the reactor component of the nuclear rocket only. There are no facilities for incorporation of a turbopump in the test facility so that the combination of reactor and flow system dynamics can be simultaneously investigated. There is no way of analyzing these combined dynamics characteristics with sufficient accuracy that safe and reliable system operation can be predicted. It is, therefore, proposed that a nuclear rocket facility be designed and constructed so that reactors can be tested with the turbopump propellent feed system that will be used in the full-scale nuclear heat transfer rocket. Because the dynamics of the reactor and flow system are not known, it is essential that the early tests of the reactor and the pump be made with a pump drive that has extremely accurate speed control. The only sufficiently satisfactory system is an electric drive system. The present facility will, therefore, supply an electric motor pump drive and required electronic speed control equipment for the early tests. When the dynamics of this system have been analyzed, the reactor will be tested with the full-scale turbopump and the turbine drive gas generator system or the full flow turbine drive gas system so that the nuclear rocket steady state and transient operation may be accurately evaluated and desirable performance obtained.

This project will supply the electrical drive motor, a variable speed coupling, required speed-control equipment, flow controls, the necessary gear boxes to deliver the required pump speed, the turbopump stand, the required gas generator system, the additional liquid hydrogen storage capacity, the required ducting to permit closely coupled reactor-turbopump operation, and the necessary building to house the drive and control equipment.

2. Cost estimate

Facility design and site preparation	$100,000
Cost and installation of electrical drive equipment	500,000
Construction of butler-type building with required foundation mounting for electric motor and turbopump facilities	150,000
Gas generator installation	350,000
Ducting and powerline connections	200,000
Remote electrical and flow-control setup	300,000
Propellant storage capacity	200,000
Instrumentation	200,000
Total estimated cost	2,000,000

Mr. THOMAS. I notice that there is $2 million in here for project ROVER, and you state as follows in your justifications:

This high impulse gives the nuclear rocket the potential of delivering a large payload into an earth orbit with a single-stage machine, whereas the chemical rocket might require at least two and probably three stages. The ROVER program now in process is aimed at the development of small, high-temperature, high-power reactors for use in high-thrust booster rockets.

What are you doing? You are trying to develop a small reactor to use in a cluster with some of your exotic fuel reactors in your big thrust; is that it?

Dr. SILVERSTEIN. Yes, sir; this is a long-term——

Mr. THOMAS. How far along are you? Is this your first year?

Dr. SILVERSTEIN. The AEC has been working on this. This is our first year.

Mr. THOMAS. You further state as follows:

At the present time the AEC Nevada test site has facilities for testing the reactor component of the nuclear rocket only. There are no facilities for incorporation of a turbopump in the test facilities so that the combination of reactor and flow system dynamics can be simultaneously investigated.

Mr. RHODES. Mr. Chairman, how does this tie in with the section we had a while ago on the development of nuclear fuels?

Dr. DRYDEN. These are the facilities that go to the test site for the support part of the reactor.

PROPULSION DEVELOPMENT FACILITIES

Mr. THOMAS. This is the real estate, so to speak; we went into the VEGA equipment a while ago. This is support equipment; is that right?

Dr. DRYDEN. That is right.

Mr. THOMAS. This is support for VEGA and the CENTAUR. These are your two big ones?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. You state in your justifications with regard to the VEGA and CENTAUR as follows:

An extensive survey of existing test stands which might be modified for these programs and possible sites for new standards is near completion.

Where? Where are you going to build these? You are going to spent for your test sites about $8 million. How firm are these figures?

You state at page 397:

Stand, including mounting tower and equipment for handling, control, and data acquisition, $1.5 million; CENTAUR captive stand, $1,750,000; central facilities for high-energy solid and liquid rocket propellent research $4,750,000.

You mean you have to have that where you test?

Dr. SILVERSTEIN. For the central facility part of the project we have not yet chosen a location.

Mr. THOMAS. These are testing stands? You are not developing anything in this program? In other words, you are spending some money with some manufacturer and when he delivers them to you, you are going to take them out and use them for test purposes?

Dr. SILVERSTEIN. He is going to test it himself. In other words, before we fire any vehicle down at Canaveral or off Cape Arguello it is most urgent that this thing be tested as a vehicle in a stand. This is where you make your money, because if you fail to make these ground tests successfully, you can expect them to fail in flight.

Mr. THOMAS. There are three paragraphs on page 396 of the justifications which are worth reading. I have them underlined, and I shall read them:

In addition to the aforementioned test stands, funds are required in the fiscal year 1960 to make a start toward a new central facility to permit an accelerated research and exploratory development effort in two additional areas of great future importance to the national space effort. Future space missions will necessitate the development of rocket engines that use high-energy liquid propellants. The advantages of the high-energy liquid propellants lie in their potentially high values of specific impulse. Solid propellant rocket engines, which produce relatively lower impulses, have important application in space missions due to their low structural and equipment weight, simplicity, and reliability.

Many of the high-energy propellants (e.g., fluorine) are extremely toxic, corrosive, and reactive. Consequently, current research facilities (NASA Lewis Research Center and the Jet Propulsion Laboratory) are severely restricted in the testing of these propellants because of their proximity to urban areas. A specialized facility located in an isolated area is therefore required. This project will provide such facilities. The facilities will be used initially for the continuation of high-energy propellent work of both the Lewis Research

Center and the Jet Propulsion Laboratory on an expanded scale of thrust and number of firings. These facilities will also be used in future development projects. The requirements of the facility are dictated largely by the hazardous nature of propellants to be investigated. Therefore, it is necessary that an isolated site be chosen and that individual facilities be adequately dispersed for efficient and safe operation.

At a Government-owned location to be determined from further studies, facilities will be provided for advanced research and development on both solid and liquid propellant rockets. The funds requested in the fiscal year 1960 will provide for initial site development and for one test stand to accommodate 100,000-pound-thrust rocket engines using high-energy propellants.

Mr. THOMAS. This project will provide those facilities and that is the purpose of this $8 million?

Dr. DRYDEN. Yes, sir.

Mr. THOMAS. It all adds up to $8 million. The stand is $1.5 million. Where do you plan to locate this? Do you plan to use White Sands?

Dr. SILVERSTEIN. The central facilities portion has not yet been located.

Mr. THOMAS. I heard you say that a while ago, Doctor.

Dr. SILVERSTEIN. We have a site——

Mr. THOMAS. But you say it is Government owned. So you must have some place in mind?

Dr. SILVERSTEIN. We have no place in mind. We would expect to use Government-owned land if we could possibly do it.

Mr. THOMAS. How did you arrive at this figure of $8 million if you do not know where you are going to put it?

Dr. SILVERSTEIN. The first two stands, one for the VEGA and one for the CENTAUR, are very well determined. They have to be in the vicinity of the contractor's plant.

Mr. THOMAS. That comprises less than one-quarter of this total amount. The CENTAUR stand is $1.7 million and the VEGA stand is $1.5 million, but in truth and in fact you are dealing with three locations here?

Dr. SILVERSTEIN. Basically, two locations: One for these two stands which will be close together, and the other location for the central facilities.

Mr. THOMAS. You may proceed.

Dr. SILVERSTEIN. The way we arrive at these numbers is based on our experience. In fact, in this particular case we investigated a remote site and made a detailed study with an engineering firm to find out what the costs were. This actually started as a part of the work that the Air Force was doing, recognizing several years ago that there was going to be a need for something like this. They made a study and we have taken over their study, which is the basis for our estimates.

In truth, I must admit that, depending upon the site, these numbers can change some.

Mr. THOMAS. Well, you have your site already on the Atlantic coast, and one already on the Pacific coast.

Dr. SILVERSTEIN. But neither of the sites we have will actually——

Mr. THOMAS. I mean the Air Force has those sites.

Dr. SILVERSTEIN. These sites are possibilities, but we are still looking to see where the site should be most advantageously located.

Mr. THOMAS. This figure of $3.2 million will wrap up this job?

Dr. SILVERSTEIN. The first two, the $1.5 million and the $1.75 million; yes, sir.

Mr. THOMAS. We expect it to.

Dr. SILVERSTEIN. These are supposed to wrap it up.

Mr. THOMAS. How often will you use the site after you spend this money on it?

Dr. SILVERSTEIN. On these stands?

Mr. THOMAS. Yes, sir.

Dr. SILVERSTEIN. I expect they will be used fairly continuously.

Mr. THOMAS. How much land is involved?

Dr. SILVERSTEIN. This is on Government land that the Air Force owns now.

Mr. THOMAS. Have you picked the site for these two?

Dr. SILVERSTEIN. These two are near the contractor's plant, a place called Sycamore Canyon, within some 12 miles of the plant.

Dr. GLENNAN. Mr. Chairman, I think it ought to be pointed out that these particular facilities are research and development facilities as against the test facilities which are located at the Pacific and Atlantic missile ranges.

Mr. THOMAS. You are going to fire from those sites also; are you not?

Dr. GLENNAN. We would not launch from these stands. We would fire at those stands in a captive position. The unit is held down and it may be that you are trying out tests on a turbopump or the burning of the engine itself, with what are known as battleship tanks.

Mr. THOMAS. When you say "in a captive position" you mean you will fire it, but it will not take off?

Dr. GLENNAN. Yes, sir.

Mr. BOLAND. Mr. Chairman, you have explored this so thoroughly that I have but very few questions. I would, however, like to say that I think we have to rely upon the sound judgment and commonsense of those who are in charge of this program, having knowledge of what the mission of the NASA is.

This is a field in which we can spend millions of dollars and in which it is conceivable we could waste an awful lot of money. I think it is generally agreed that we have wasted a lot in our missile development. So it is the responsibility of the agency with respect to this program which, of course, is a very heavy one. I think they realize it quite thoroughly.

UNIDENTIFIED FLYING OBJECTS

I want to turn attention to something for a moment which has been in the press over the past 12 years, and that is with respect to unidentified flying objects. All of the words that I have heard during the past several days here indicate that we can travel in space, and that we will travel in space, and that we will do so relatively soon.

Is there any reason to believe that life does exist on other planets?

Dr. DRYDEN. As far as I know, the only evidence from planets which are near us are colorations on the surface which seem to change. What kind of life this indicates, we do not know. It may be only moss, or something of that sort. We have seen no positive evidence of human life anywhere on the planets which are near us.

When you start talking about systems outside of our own solar system, we do not have any information.

Mr. BOLAND. Is it conceivable that some of the other planets have achieved space travel?

Dr. DRYDEN. Well, if there are people there and if they have been there for many thousands of years, of course, it is conceivable.

If they are people like ourselves, they certainly would move in these directions, but we have no positive evidence of anything of this kind.

Mr. BOLAND. Do you have any records with respect to unidentified flying objects?

Dr. DRYDEN. We have not as an agency made any investigation of the objects. The Air Force has, and it has spent a good many thousands of dollars trying to run down each reported case.

Now, what they run into is that the phenomena in the atmosphere are extremely complicated. They have been able to account for each—I have forgotten the number, but perhaps three-fourths of these. They have had experiences of a pilot in an aircraft seeing the planet Venus and thinking this was some object. There have been other appearances associated with these tremendously big balloons that are sent up for cosmic ray measurements. There are certain cloud formations and refractions of light, according to some people who have investigated it. In about three-fourths of the cases they have been able to identify the reason.

I, personally, have no doubt that the people who say they see these things are perfectly honest in that it was something that they saw. It is the interpretation. We have never seen a piece of any flying saucer. We have never seen any physical evidence. I guess it comes down to the fact that those of us who have a somewhat skeptical attitude toward this like to be convinced that there is some more positive evidence than what you see with your eyes, because all of us have been in situations where we know that our eyes have fooled us very much.

Mr. BOLAND. In other words, you would like to have as conclusive proof as possible?

Dr. DRYDEN. Yes, sir.

Mr. BOLAND. You would like to have some substantive evidence and feel the object?

Dr. DRYDEN. Yes, sir.

Mr. BOLAND. All of this has been picked up on radar and it has been seen.

Dr. DRYDEN. Radar shows many so-called ghosts, and many of them arise right in the equipment, and are well understood.

The electrical pulses in the equipment give false images.

A rainstorm gives an image on a radar screen. Lots of things give pips on the radar screen, and it takes great skill by the operator to distinguish those pips on the scope.

Experienced radar operators and other experienced people and people generally have tried to observe what magicians do on the stage and we find that our eyes are not always reliable in interpreting what we see.

I do not want to prolong the discussion, but during the war we set up a target which was a sphere covered with wire screen and held it

up in the air with a captive balloon. We had a radar-homing glider to aim at it. A lot of people stood on the ground and observed it. One man would swear positively it went to the right, another would swear positively it went to the left. They were both right. It did not pass on the level. The reason for this is it did not pass on the level, it actually passed below. The eye is not a scientific instrument.

Mr. BOLAND. Is there any scientific evidence that some of these objects might represent something from outside the world's atmosphere?

Dr. DRYDEN. We have no basis for making such an assumption. Most cases, upon investigation, have proved to have been helicopters, balloons, stars, cloud formations, searchlight beams on clouds. I have seen helicopters in formation with the sun on them in a certain way that gives a very peculiar type of appearance. We do not challenge the honesty of the observers. They saw something in the sky.

Mr. BOLAND. We have trained airline pilots and trained radar operators who report these things. NASA has no direct information on whether or not these are actual objects coming from some other planet?

Dr. DRYDEN. No.

Mr. BOLAND. That is all.

BUREAU OF BUDGET ACTION ON NASA ESTIMATES

Mr. YATES. I turn to page 9 of the Administrator's statement, and I read:

> Adequate support of research implies long term and continuous funding. The bad habit of coming forth with huge sums and crash programs only when outside events generate a hysterical sense of urgency is dangerously irresponsible. * * *

How much money did you ask of the Bureau of the Budget, Dr. Glennan?

Dr. GLENNAN. This tentative budget when first proposed to me by our staff ran close to $625 million. In our first analysis of this estimate with the Advanced Research Projects Agency it was revised because of duplications very close to a hundred million dollars. This was because we were both developing our programs at that time. This was back in October and November of last year. We went into business on October 1. Our revised estimate was about $523 million.

After our discussions with the Bureau of the Budget, our estimate came down to $485 million, a reduction of about $38 million. I think that last reduction is the one that is significant.

Mr. YATES. The reduction suggested by the Bureau of the Budget will not interfere with your work, will it?

Dr. GLENNAN. We have reexamined our program. I make the point to you very emphatically that this is a very fast moving field that we are learning as we go, that in the period between the start of our budget preparation and today I believe we have a sounder program than we had then. I believe what we have been able to do in the matter of replanning our activities makes this $38 million very much less significant than it seemed to us to be at the time.

I would like to point out in this regard that the very substantial sum of money we are programing here for the development of new vehicles—it is about a hundred million dollars, I believe—is now the result of a fairly well laid on program looking 6 or 8 years ahead,

so that we have a spectrum of vehicles of varying capacities which one would hope will give us whatever kind of a payload capacity we want, a minimum number, so that one is not cadging up something for each different experiment, we are not quite developing off-the-shelf items but rather, standard vehicles, made up from the different parts. We will have a number of second stages, a number of third stages, a number of base boosters, etc. By putting combinations together properly we can get a variety of capabilities.

We could have gone on and answered what I term pressures—I think that is an advised word—and kept firing vehicles presently available to us, such as the THOR, THOR-ABLE, JUNO II, which have very limited payload capacity and essentially less than we were at first led to believe.

This would have meant the cost per pound we could get into orbit, the cost per experiment of what we could get into orbit, was inordinately high. We believe it is part of good management to limit the firings today somewhat while we put our effort into getting the kind of vehicles which will give us a much greater capacity as time goes on.

The THOR-DELTA program is, I would say, an interim program, although the THOR-DELTA will probably wind up with 20, 30, or 40 vehicles before we get through. It moves our capacity with the presently available booster up to some 250 or 300 pounds, which will get us into the second generation experiments.

I would not want to leave with the committee any idea that what we are doing is building a single-pupose vehicle which is going to be used once, twice, three or four times, and then move to something else. This family of vehicles, sort of an on-the-shelf stable, if you will, will be used for a variety of purposes and one hopes over many, many years to come.

Mr. YATES. The number of firings which you will make using existing vehicles is limited?

Dr. GLENNAN. Yes, sir.

Mr. YATES. Is this true of the military as well?

Dr. GLENNAN. Yes, I think it is true of the military as well. They are depending upon this same family of vehicles being available to them. In addition, they have one vehicle they are using today called the THOR-HUSTLER, putting the Discoverer into orbit, which is an engine—the second stage has been under development for some years—part of an aircraft development, a missile engine made by Bell Aircraft. That has been converted to be used in the Discoverer series and it may also be used as an ATLAS-HUSTLER vehicle. That is an interim vehicle for them as well.

MILITARY SPACE PROGRAMS

Mr. YATES. They make their shoots in order to obtain military information?

Dr. GLENNAN. That is right.

Mr. YATES. Do they use the instrumentation in their missiles that you use in yours?

Dr. GLENNAN. Similar instrumentation, many times identical instrumentation.

Mr. YATES. What is the difference in the shoots?

Dr. DRYDEN. The instrumentation in common is that monitoring performance of the vehicle. Their payloads are quite different. They are developing, as you know, a reconnaissance satellite. This is the aim of the development. The Discoverer is a preliminary vehicle getting information on stabilization of the satellite, performance of various equipments, suitable for their military mission.

Mr. YATES. Does it serve a useful purpose for them to shoot these vehicles as well as yourselves?

Dr. DRYDEN. Yes. They are developing a military system. We are discussing with them this point: Do you have any space and weight available for carrying scientific experiments? We are in the process now. They are going to do a certain number of animal experiments.

I understand you referred to that earlier this morning. There is an aeromedical program laid on there which is part of the supporting effort of Project Mercury. We are also discussing with them whether they have room to put in some of their firings radiation measuring equipment, magnetic field measuring equipment.

Mr. YATES. Does this duplication—I do not know whether the word carries any invidious meaning—but does this dual system of rocketry carry with it an unnecessary expense?

Dr. DRYDEN. I do not think so. In the first place, this system, as we mentioned, is really an existing and fairly old system made up of the THOR, the THOR booster, and this HUSTLER, which I believe was in one of the——

Mr. YATES. Is the military not going to seek bigger and better missiles?

Dr. DRYDEN. They are.

Mr. YATES. Are they developing them themselves?

Dr. DRYDEN. The CENTAUR itself is based on a more advanced system and will use an ATLAS-boosted satellite package.

COORDINATION OF EFFORT

Dr. GLENNAN. I think the question being inquired about is: Are they going to build booster systems competitive with ours?

Mr. YATES. You are going to build the CENTAUR at a substantial cost. Will the military have other vehicles it is developing or is it relying entirely on your agency to develop future vehicles?

Dr. DRYDEN. Beyond the vehicles now in existence, this coordinate program is supposed to include the needs of both. They have, as we outlined, the SATURN vehicle at ABMA and are financing and developing that. At the present time we are developing and financing the others.

Mr. YATES. Why should you not be doing all of them?

Dr. DRYDEN. It is a good question as to why one or the other should do everything in a given line. In the first place, it is a terrifically big job to do all of it. We are represented in the technical management of it, but we do not carry the complete technical supervision. If we had that within our organization, we would have to further expand the number of people in order to follow it intelligently.

Mr. YATES. Is there not a diffusion of knowledge and responsibility when you have this dual system?

Dr. DRYDEN. Again I come back to the intent of Congress, which did not say that the military should not do space or that we should do it all, that there was under consideration the possibility that there be a single agency to do all space, both civilian and military, and for various reasons this was not the way in which the program was set up.

Mr. YATES. You really have not answered my question, have you? You have talked about the intent of Congress and I was not talking about the intent of Congress.

Dr. DRYDEN. I do not think there is any virtue in one agency having a monopoly of any technology. I think the technology is too big and too broad to concentrate in any single agency of Government. It is like saying you will concentrate production of missiles in one factory. The job is so big that you do it more effectively and efficiently by some subdivision of it.

Mr. YATES. It is true, but the job is so important as well as big that you seek to allocate responsibility to a particular group. My question was directed to the fact that here you have a dual system. One wonders whether or not there is sufficient channelization of responsibility.

Dr. DRYDEN. We have one system of vehicles and allocation of responsibility for particular vehicles. This is because the job is so big.

ESTIMATED COST OF FUTURE YEARS' SPACE PROGRAMS

Mr. YATES. I would like to press the few questions I asked earlier in the hearing today, which were with respect to the foreseeable expenses of your program. You stated you foresaw the cost as being approximately a billion dollars a year for the next few years, I think.

Dr. GLENNAN. I wonder if I could try to illustrate the manner in which it seems to me we might get at this. If one takes a block of costs here, which are NASA research centers, this is an ongoing expense so long as the Nation wants NASA to be in the aeronautical and space research business, just as NACA has been.

You build on top of that the support activity in basic sciences in space. Now, one builds discrete projects on top of this from time to time. Here is the man-in-space project. This is one that we hope to be able to solve in the course of the next 2 or 3 years. One may build a project on top of that. Probably before this I should mention the vehicle program, which is a program that over the years is going to increase in cost until we get to the point of having the vehicles available, when the cost should come down like this.

Suppose that another year from now it appears that it is time for us to get into the business of knowing, can you or can you not hit the Moon and make a soft landing on the Moon? You again build at least a piece on top of this.

Actually, you have a basic program here and this is probably part of the basic program. Then come specific projects, which can get to be fairly expensive projects.

As I see it, that is the way in which this program will build.

Mr. YATES. Can you translate that in terms of expected costs?

Dr. GLENNAN. I have said—and this is really an off-the-top-of-my-head estimate—that I think perhaps our budget for 1963 would be in the billion-dollar range. Frankly, I do not see why it should go very much larger than that unless we find out something which just pushes us very, very hard.

Mr. YATES. You do not see any diminution of that beyond 1963?

Dr. GLENNAN. Yes; I see it beyond 1963, and I see it beyond 1963 in the sense by that time one would hope that the bulk of the heavy investment in the development of the large vehicular systems will be behind us and we would then be buying a unit which to develop might have cost you as a ballistic missile costs you, a billion dollars to develop, but you buy one for a few million dollars. It is that kind of diminution that I see going in the future while one keeps this kind of level of effort.

This is the way NACA has run over the years. A level of effort was established to maintain leadership in the field of aeronautic research. In this situation, if we believe what the Congress has written into the law, it is our Nation's intent to maintain leadership in both the aeronautical and the space sciences. This requires the expenditure of money. It is unfortunate that it is an exceedingly expensive business, that so much of what we are doing gets lost, that you do not use it the second time.

Mr. YATES. Apparently, the more we know, the less we know. The field continues to expand with each bit of knowledge accumulated and with each bit of knowledge comes an extension of the frontier and the need for additional financing.

COMMERCIAL BENEFITS

Dr. GLENNAN. The one wonderful thing—the fortunate thing about it is I do not quickly recall any instance where learning something more about a phenomenon has not ultimately resulted in something of very great value to man. This is a matter where one has great faith or he slides backward.

Dr. SILVERSTEIN. There are some interesting points here. You will notice on sale in the stores now a little transistorized radio with solar cells on top. You can take them on the beach and play your radio without a battery, just from the rays of the sun.

Mr. YATES. I had not seen them.

Dr. SILVERSTEIN. They are out. They are produced by the Hoffman Co. They are the people who put the solar cells in the satellite, the same materials are used.

This is a graphic illustration of how out of the basic research and development you do in one field there is a widespread gain in all other fields. This has been the history of our development. This transistorization, for example, by which you get radios this big has come about as a result of developments in the past few years in our missile and space field wherein you take a package—we can build radio sets that we send out into space that will broadcast from a distance of 20,000 miles; we can build them this big.

Mr. YATES. About the size of a small transistor radio?

Dr. SILVERSTEIN. Yes. These are much more miniaturized than the sets you buy now. These developments feed into our industrial life and create a growth in it that I do not think you can measure at any one time, but if you watch the tremendous expansion of our industrial growth, a lot of it is reflected by the basic research and development we have done in associated fields.

PATENT POLICY

Mr. YATES. Your last point raises this question in my mind. What happens to patentable items discovered as a result of Government development contracts? For example, are you using solar energy in your satellites or are you attempting to use it? Suppose this was developed as a result of a Government development program. What happens to such patents?

Dr. GLENNAN. Mr. Nunn from our legal staff can answer that.

Mr. NUNN. With respect to the contracts that NASA is engaged in, the statute requires that the contractor—and we include a clause in our contracts that requires the contractor—to report inventions made in the performance of his work. By that means information as to inventions is funneled into NASA. Our patent attorneys review it and upon that basis the Administrator then is obliged to make determinations as to whether the invention is of a class to be waived so that the patent or the ownership of the invention is vested in the company or the inventor, or whether the United States in its own interest should take title to it.

Similarly, the Administrator makes determinations with respect to licensing. This general arrangement whereby the United States takes title to patents is similar, I believe, in that respect to the Atomic Energy Commission. It differs, I believe, with respect to the Department of Defense and their relations with their contractors.

CENTAUR PROJECT

Mr. RHODES. Who is the primary contractor of the CENTAUR system?

Dr. GLENNAN. It will be the Convair people.

Mr. RHODES. They are also developing the VEGA system?

Dr. GLENNAN. Yes, and the reason is they both use an ATLAS as the base booster and the configuration of both the VEGA and the CENTAUR are being made just as similar as possible so they can use the same tooling. We ought to save money on getting these. One of them uses a different fuel from the other, but they are both of the same general configuration.

The CENTAUR happens to have longer fuel tanks because hydrogen is a much lighter material than kerosene.

Mr. RHODES. You are not using the TITAN system at all?

Dr. GLENNAN. Not as yet.

Mr. RHODES. Is there any particular reason?

Dr. DRYDEN. This is in the program under consideration for upper stages on both the SATURN and NOVA.

Dr. GLENNAN. Those are farther in the future.

ROLE OF MILITARY SERVICES IN SPACE RESEARCH PROGRAMS

Mr. RHODES. Mr. Yates was asking some questions that I think are rather important, and I would like to pursue one further. That is the way the armed services fit into this thing.

Actually, is there any reason why the armed services in development of this art should go beyond the point at which they can deliver

a hydrogen warhead anywhere that they need to deliver it? Is there anything in the military picture that you can see which would require them to be interested any further than that?

Dr. GLENNAN. Yes, I think so. I would just as soon go off the record.

Mr. RHODES. Off the record.

(Discussion off the record.)

Mr. RHODES. Is there any reason you can think of why the military should be particularly interested in the development of high-thrust engines?

Dr. GLENNAN. Only to the extent they need more thrust than is presently available to them for getting heavy payloads into this 22,000-mile orbit, which is one of the most difficult orbits we will atempt. Here, if you are going to put up a communications satellite, there is no use putting one up that only has sufficient power equipment in it to last for a month. You want something that will last for years. This may mean solar cells and other things. One looks at a communications satellite as something that will weigh 10,000 pounds or more.

Mr. THOMAS. It is difficult to separate your effort from that of the research efforts of the armed services. It must be that way. There is no need to build an automobile that will run just 20 miles an hour or there is no need to build a rocket that will just go 10 miles.

Dr. GLENNAN. The rockets we will build will be used by the military, I am very certain. That is why we have what is known as a national booster program, which is very, very closely coordinated.

The military operations here, it seems to me, are those looking toward the end item, the operational system to perhaps a greater extent than our activities.

We will be doing this, too, in the sense that in our communications satellite activities we will be working with some commercial companies on some sound basis that protects the interests of the people as well as giving private industry a chance to develop in this general area, but behind all this our basic purpose here is research and development and exploration. This is written in law, this is the basic purpose NACA has served for years.

Mr. RHODES. Is there any limiting factor to your work other than the needed thrust in the booster system?

Dr. GLENNAN. Guidance and control systems need a great deal of work on them as yet. Just the acquisition of an awful lot of knowledge we presently do not have.

Mr. RHODES. Do you feel that this budget provides all of the money which you could spend in fiscal 1960 on a sound research basis?

Dr. GLENNAN. I have testified over the past several weeks and months to the effect that I do believe this budget will provide us with the means for moving ahead on a sane, well-planned program, at a rational speed.

As time goes on, with the rapid changes in the field, it is wholly possible we will find this terribly tight. That is, if this committee should decide in its wisdom that, well, estimates are estimates, so you can get along with 10 percent less or 20 percent less, whatever amount one wants to pick out of the air in a situation like this—these estimates have been made, I think, very carefully and by people who are really

diligent and competent in these fields, and every day they get tighter, every day as we look ahead they get tighter. The problems we are facing look tougher. There is just no other way I can express this to you sincerely.

ADEQUACY OF APPROPRIATION ESTIMATES

Mr. RHODES. I feel a great sense of urgency about this program. I want to know: could you logically spend more money this year?

Dr. GLENNAN. In some areas I think we could spend more money this year. I am, however, of the opinion that we are not going to lose any ground if we follow a program of this sort.

What seems to me to be important here—and it is what I tried to convey, Mr. Yates, in the passage which you were quoting there—is that to push this at too rapid a rate is going to break us, physically and mentally. My staff is really beat. We have been working almost around the clock. There is a pace beyond which one should not be pushed except in the wartime urgency situation where you just have ships outside the door being sunk and that sort of thing.

I believe in this area, too, where we are attempting to acquire brand-new knowledge that it takes time to analyze the data that comes back to us, to evaluate that data and make sense out of it so we can plan sensibly the next experiment.

One can look at the meteorological program and find that in the next 2 years we have only four satellite launchings laid on. People say, why, those lazy so-and-sos.

Mr. YATES. The people around this table do not look haggard enough to justify that. They look well to me.

Dr. GLENNAN. People have given me the devil for this.

Let me finish this thought. Why have we not laid on a firing every month in the meteorological satellite deal? Because it is our opinion that it will take time to get the data back, broken down, analyzed, and to know what next one should do sensibly. These things take a year and a half and 2 years sometimes to build the payloads, test them, get them ready to go. Suppose we start building just one after the other and one of these experiments gives us, as our old friend, Mr. Strauss, used to say, a quantum jump in knowledge. Why fire the rest? We have to start over again and reexamine the program we have laid on back here a long time back.

We have a program that is sensibly laid out. I would invite my colleagues to speak on this because we are a team. Do you have any comment on this?

Dr. SILVERSTEIN. I think this program we have is a sound program. I think there is a question as to whether or not as it moves along, there is the matter of overages that can occur that could put you in trouble. This is a thing you do your best job of estimating that you can, admitting they are estimates. You know there are unforeseen things that occur in every program, and when you run into them you have to take care of them. I hope we do not have too many of these sorts of things because if we do, it will upset our program.

LAND PROCUREMENT—WALLOPS ISLAND

Mr. THOMAS. How many acres of land did you buy at Wallops with your last year's money? Some gentleman inquired about it.

Mr. ULMER. We have procured to date about 350 acres on the mainland and about 900 acres of marshland between the mainland and Wallops Island.

Mr. THOMAS. What did you pay for it?

Mr. ULMER. It averaged $100 an acre for the mainland area and $10 an acre for the marshland.

Mr. THOMAS. Do you not have enough land which the Navy transferred without buying this land? Some gentleman complained about it.

Dr. GLENNAN. Can you explain why we put the radar there?

Dr. SILVERSTEIN. Initially we were going after a great deal more land than this 3,400 acres. Now we will be buying only about 1,600 acres. We are going to move the major part of the mainland facilities to Chincoteague. We are going to take our telemetry station to Chincoteague. The large radar installations, however, cannot be placed alongside a runway because there is interference between the pattern on the radar and the ground equipment for landing the airplane. So it is necessary to have enough land around these installations to install them.

Mr. THOMAS. Is there anything further?

Dr. GLENNAN. I hope I may urge you to help us as much as possible in speeding up at least the passage of the supplemental 1959. This is terribly important as we move forward in this program.

Second, I note that you skipped over the Beltsville thing. I presume our earlier discussion covered that all right.

Mr. THOMAS. It was covered pretty well.

Gentleman, it was a pleasure to do business with you. Thank you for a fine presentation. Come back to see us.

BUDGET ESTIMATE FOR 1960

Mr. THOMAS. The authorization for the National Aeronautics and Space Administration became a law on June 15 and on June 16 the President submitted a budget estimate for the Administration for 1960. The proposed appropriation langauge as contained in House Document 173 will be inserted in the record at this point.

(The matter referred to follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SALARIES AND EXPENSES

For necessary expenses, not otherwise provided for, of the National Aeronautics and Space Administration, including *rental of office space within the District of Columbia; hire of passenger motor vehicles; and* uniforms or allowances therefor, as authorized by the Act of September 1, 1954, as amended (5 U.S.C. 2131) [, $5,000,000]; *$94,430,000.*

RESEARCH AND DEVELOPMENT

For contractual research, development, operations, technical services, repairs, alterations, and minor construction, and for supplies, materials, and equipment, *and for other items of a capital nature as authorized by law*, necessary for the conduct and support of aeronautical and space research and development activities of the National Aeronautics and Space Administration, including *not to exceed $9,000 for representation allowances overseas and official entertainment expenses, to be expended upon the approval or authority of the Administrator; not to exceed $500 for newspapers and periodical; and* purchase of [three] *sixty-five* passenger motor vehicles, *of which thirty-eight shall be for replacement only* [, $50,000,000]; *$33,070,000*, to remain available until expended.

CONSTRUCTION AND EQUIPMENT

For construction and equipment [at laboratories and other installations of] *for* the National Aeronautics and Space Administration and for the acquisition or condemnation of real property, as authorized by law, [$25,000,000] *$57,800,000*, to remain available until expended.

Budget Tables

Mr. Thomas. The green sheets for the Administration's budget will be inserted at this point.

(The matter referred to follows:)

National Aeronautics and Space Administration

SALARIES AND EXPENSES

Program and financing

	1958 actual	1959 estimate	1960 estimate
Program by activities:			
1. Aircraft, missile, and spacecraft research:			
(a) Aerodynamics and space mechanics	$43,658,690	$48,340,000	$41,800,000
(b) Powerplants	19,709,942	21,640,000	18,800,000
(c) Structures and materials	8,672,725	9,598,910	8,300,000
(d) Aircraft operating problems	2,326,274	2,700,000	2,200,000
2. Space flight development and operations		2,540,000	17,600,000
3. Headquarters management and coordination	1,891,774	3,940,000	6,300,000
Total program costs	76,259,405	88,758,910	95,000,000
Supplies or services transferred in (−) without charge, net	−1,866,959	−1,300,000	
Total program costs, funded	74,392,446	87,458,910	95,000,000
4. Relation of costs to obligations:			
Costs financed from obligations of other years' net (−)		−2,016,691	−570,000
Obligations incurred for costs of other years, net	2,664,948		
Total program (obligations)	77,057,394	85,442,219	94,430,000
Financing:			
Comparative transfers from (−) other accounts	−76,045,613		
1959 appropriation available in 1958	−1,011,781	1,011,781	
New obligational authority		86,454,000	94,430,000
New obligational authority:			
Appropriation		5,000,000	94,430,000
Transferred from "Salaries and expenses," National Aeronautics and Space Administration (72 Stat. 432)		78,100,000	
Appropriation (adjusted)		83,100,000	94,430,000
Proposed supplemental due to pay increases		3,354,000	

4. Relation of costs to obligations

	1957 actual	1958 actual	1959 estimate	1960 estimate
Selected resources at end of year:				
Inventories and items on order:				
Stores (goods unconsumed by projects)	$1,240,878	$2,514,811	$1,800,000	
Unpaid undelivered orders (appropriation balances obligated for goods and services on order not yet received)	2,877,153	5,472,781	4,200,000	$175,000
Advances (payments for goods and services on order not yet received)	43,559	94,869	88,000	
Accrued annual leave (leave earned and not taken by employees, charged to activity costs)	−3,700,005	−4,677,125	−4,700,000	−5,100,000
Unapplied costs (costs incurred not yet assigned to activities)	170,719	382,480	383,125	155,000
Total selected resources at end of year	632,304	3,787,816	1,771,125	−4,770,000
Selected resources at start of year (−)		−632,304	−3,787,816	−1,771,125
Adjustment of selected resources reported at start of year		−490,564		
Transfer of selected resources to "Research and development" appropriation for items to be procured under that appropriation in the fiscal year 1960:				
Stores				1,800,000
Unpaid undelivered orders				4,083,125
Advances				88,000
Costs financed from obligations of other years, net (−)			−2,016,691	−570,000
Obligations incurred for costs of other years, net		2,664,948		

Object classification

		1958 actual	1959 estimate	1960 estimate
	Total number of permanent positions	7,892	8,961	9,988
	Full-time equivalent of all other positions	1	3	15
	Average number of all employees	7,806	8,300	9,613
	Number of employees at end of year	7,818	8,906	9,918
	Average GS grade and salary	9.1 $6,965	9.1 $7,587	9.3 $7,773
	Average salary for grades established by the Administrator of the NASA	$5,766	$5,943	$5,934
01	Personal services:			
	Permanent positions	$50,857,864	$58,301,495	$68,850,135
	Positions other than permanent	925	20,000	105,000
	Other personal services	517,584	655,405	1,020,865
	Total personal services	51,376,373	58,976,900	69,976,000
02	Travel	402,178	1,212,500	3,181,000
03	Transportation of things	201,973	279,000	349,000
04	Communication services	224,348	438,450	3,827,000
05	Rents and utility services	1,280,515	2,089,400	4,212,000
	Electric power	6,349,831	7,052,900	7,669,000
06	Printing and reproduction	119,476	139,140	210,500
07	Other contractual services	689,229	785,763	213,560
	Research contracts	410,000	850,000	
	Repairs and alterations	1,119,757	1,055,270	
	Services by other agencies	115,284	135,330	
	Research services	90,000	150,000	
	Security investigations	118,015	180,000	350,000
08	Supplies and materials	7,120,273	6,099,652	
09	Equipment	3,275,013	3,250,150	
11	Grants, subsidies, and contributions	3,141,148	3,740,275	4,420,540
13	Refunds, awards, and indemnities	2,079	5,000	6,000
15	Taxes and assessments	10,121	14,270	15,400
	1959 program obligated in 1958	1,011,781	−1,011,781	
	Total obligations	77,057,394	85,442,219	94,430,000

RESEARCH AND DEVELOPMENT

Program and financing

	1958 actual	1959 estimate	1960 estimate
Program by activities:			
1. Aircraft, missile, and spacecraft research		$2,000,000	$20,000,000
2. Scientific investigations in space		12,000,000	63,541,282
3. Satellite applications investigations		1,000,000	7,000,000
4. Space operations technology		4,000,000	38,000,000
5. Space propulsion technology		3,078,250	22,000,000
6. Space systems technology			3,000,000
7. Tracking and data acquisition		1,000,000	9,000,000
8. Vehicle development		2,000,000	40,000,000
Total program costs		25,078,250	202,541,282
9. Relation of costs to obligations: Obligations incurred for costs of other years, net		192,291,282	130,528,718
Total program (obligations)		217,369,532	333,070,000
Financing: Unobligated balance transferred from "United States scientific satellite," Department of Defense (72 Stat. 433)		−25,541,282	
New obligational authority		191,828,250	333,070,000
New obligational authority:			
Appropriation		$50,000,000	$333,070,000
Proposed supplemental appropriation		20,750,000	
Transferred (72 Stat. 433) from—			
"Salaries and expenses, Advanced Research Projects Agency, Department of Defense"		59,200,000	
"Aircraft, missiles, and related procurement, Air Force"		45,100,000	
"Research, development, test, and evaluation, Air Force"		12,700,000	
"Research, development, test, and evaluation, Army"		4,078,250	
Appropriation (adjusted)		191,828,250	333,070,000

9. Relation of costs to obligations

	1958 actual	1959 estimate	1960 estimate
Selected resources at end of year: Inventories and items on order:			
Stores (goods unconsumed by projects)		$12,000,000	$15,000,000
Unpaid undelivered orders (appropriation balances obligated for goods and services on order not yet received)		178,291,282	309,791,125
Advances (payments for goods and services on order not yet received)		2,000,000	4,000,000
Total selected resources at end of year		192,291,282	328,791,125
Selected resources at start of year (−)			−192,291,282
Selected resources transferred from "Salaries and expenses" appropriation for items procured under that appropriation prior to the fiscal year 1960:			
Stores			−1,800,000
Unpaid undelivered orders			−4,083,125
Advances			−88,000
Obligations incurred for costs of other years, net		192,291,282	−130,528,718

Object classification

	1958 actual	1959 estimate	1960 estimate
Total number of permanent positions		161	
Average number of all employees		93	
Number of employees at end of year		161	
Average GS grade and salary		10.3 $7,671	
Average salary for grades established by the Administrator of the NASA		$5,867	
01 Personal services:			
Permanent positions		$708,000	
Other personal services		197,000	
Total personal services		905,000	
02 Travel		350,000	
07 Other contractual services		5,000	
Contractual research, development, operations, technical service, repairs, alterations, and minor construction:			
By universities		19,078,250	$35,000,000
By Government agencies		99,145,282	65,000,000
By non-Government agencies		24,805,000	163,500,000
Alterations		400,000	2,570,000
08 Supplies and materials		64,965,000	52,000,000
09 Equipment		7,670,000	15,000,000
11 Grants, subsidies, and contributions		45,000	
15 Taxes and assessments		1,000	
Total obligations		217,369,532	333,070,000

CONSTRUCTION AND EQUIPMENT

Program and financing

	Costs to this appropriation					Analysis of 1960 financing			
	Total estimate	To June 30, 1957	1958 actual	1959 estimate	1960 estimate	Deduct selected resources and unobligated balance, start of year	Add selected resources and unobligated balance, end of year	Appropriation required for 1960	Appropriation required to complete
Program by activities:									
1. Langley Research Center	$56,511,735	$13,602,301	$7,774,896	$9,800,000	$11,000,000	$20,754,538	$14,334,538	$4,580,000	
2. Ames Research Center	25,572,930	2,607,901	913,043	1,950,000	9,000,000	13,546,986	11,101,986	6,555,000	
3. Lewis Research Center	54,068,189	12,173,354	7,469,374	11,000,000	6,000,000	16,565,461	17,425,461	6,860,000	
4. High-Speed Flight Station	2,805,000				500,000		2,305,000	2,805,000	
5. Space Projects Center	17,750,000			750,000	3,000,000	3,000,000	14,000,000	14,000,000	
6. Jet Propulsion Laboratory	9,000,000			2,000,000	1,000,000	7,000,000	6,000,000		
7. Pilotless Aircraft Station	23,034,044	72,574	163,234	3,500,000	8,000,000	19,298,236	11,298,236		
8. Pacific Missile Range	3,000,000				1,000,000		2,000,000	3,000,000	
9. Various locations	35,250,000			1,000,000	3,500,000	14,250,000	30,750,000	20,000,000	
Reserves	45,319					45,319	45,319		
Total program costs	227,037,217	28,456,130	16,320,547	30,000,000	43,000,000	94,460,540	109,260,540	57,800,000	
10. Relation of costs to obligations: Obligations incurred for costs of other years, net			3,797,559	30,276,830	12,000,000				
Total program (obligations)			20,118,106	60,276,830	55,000,000				
Financing:									
Comparative transfer from other accounts			−20,118,106						
Unobligated balance brought forward					−41,404,808				
Unobligated balance transferred from "Construction and Equipment, National Advisory Committee for Aeronautics" (72 Stat. 432)				−29,431,638					
Unobligated balance carried forward				41,404,808	44,204,808				
New obligational authority				72,250,000	57,800,000				
New obligational authority:									
Appropriation				25,000,000	57,800,000				
Proposed supplemental appropriation				24,250,000					
Transferred from "Construction and Equipment, National Advisory Committee for Aeronautics" (72 Stat. 432)				23,000,000					
Appropriation (adjusted)				72,250,000	57,800,000				

10. Relation of costs to obligations

	1957 actual	1958 actual	1959 estimate	1960 estimate
Selected resources at end of year: Inventories and items on order:				
Unpaid undelivered orders (appropriation balances obligated for goods and services on order not yet received)	$18,925,630	$22,163,679	$52,305,732	$64,055,732
Advances (payments for goods and services on order not yet received)	55,713	615,223	750,000	1,000,000
Total selected resources at end of year	18,981,343	22,778,902	53,055,732	65,055,732
Selected resources at start of year (−)		−18,981,343	−22,778,902	−53,055,732
Obligations incurred for costs of other years, net		3,797,559	30,276,830	12,000,000

Object classification

	1958 actual	1959 estimate	1960 estimate
09 Equipment	$2,000,000	$10,400,000	$17,000,000
10 Lands and structures	18,118,106	49,876,830	38,000,000
Total obligations	20,118,106	60,276,830	55,000,000

Language Changes

Mr. Thomas. The statement relating to changes in appropriation language will be included in the record at this point.

(The statement follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Discussion of Proposed Changes in Appropriation Language for Regular Estimates of Appropriations, Fiscal Year 1960

Salaries and expenses

CHANGE	DISCUSSION
"including rental of office space within the District of Columbia"	Public Law 86-20, approved May 13, 1959, amends section 203(b)(3) of the National Aeronautics and Space Act of 1958 by adding: "to acquire by lease or otherwise, through the Administrator of General Services, buildings or parts of buildings in the District of Columbia for the use of the Administration for a period not to exceed ten years without regard to the Act of March 3, 1877 (40 U.S.C. 34)". The subject change is a desirable addition of language to assure that adequate space be provided for NASA headquarters activities.
"rental of motor vehicles"	To permit the use of the "Salaries and expenses" appropriation for vehicle rentals. This provision is ordinarily comprehended within the appropriation providing funds for vehicle purchase. Under the NASA appropriation structure, however, all equipment procurement, including the purchase of vehicles, is funded under the "Research and development" appropriation while the costs of all rentals are funded under the "Salaries and expenses" appropriation.

Research and development

"and for other items of a capital nature as authorized by law"	To give effect to the provision in section 1(b) of H.R. 7007 (NASA Appropriation Authorization Act for the fiscal year 1960) which authorizes the use of research and development appropriations for certain items of a capital nature which may be required for the performance of research and development contracts.
"including representation allowances overseas and official entertainment expenses, not to exceed $9,000, to be expended upon the approval or authority of the Administrator"	To permit oversea personnel, for example, tracking station managers, to comply with local customs regarding entertainment of dignitaries ($7,000), and to provide a modest fund for official entertainment approved by the Administrator ($2,000).
"newspapers and periodicals not to exceed $500"	To increase the existing limitation from $100 to $500. The amount of $100 has been found to be seriously inadequate to provide for subscriptions to newspapers and periodicals required by staff personnel in the conduct of their official duties.
"and purchase of 65 passenger motor vehicles, of which 38 shall be for replacement only."	To permit the normal replacement of passenger motor vehicles meeting prescribed standards, and to increase by 27 the total number of passenger motor vehicles as follows:

Lewis Research Center (Plum Brook): Station wagons	3
Goodard Space Center:	
Domestic installations:	
Sedans	3
Station wagons	6
Foreign installations:	
Sedans	3
Station wagons	6
Patrick Office: Station wagon	1
Western Office: Sedan	1
Jet Propulsion Laboratory:	
Sedans	3
Station wagons	1
Total	27

Passenger Carrying Automobiles and Aircraft

Mr. Thomas. The tables regarding passenger carrying automobiles and aircraft will be inserted in the record at this point.

(The tables follow:)

Statement of proposed obligations for purchase and hire of passenger motor vehicles for the fiscal year 1960

Appropriation	Motor vehicles to be purchased		Old vehicles to be exchanged		Net cost of vehicles to be purchased	Old vehicles still to be used	Cost of hire of motor vehicles [1]	Users and public purpose
	Number	Gross cost	Number	Allowance (estimated)				
Salaries and expenses, National Aeronautics and Space Administration.							$1,300	For use of the Administrator in attending meetings and conferences in the Washington area.
Research and development, National Aeronautics and Space Administration.	35	$52,500	25	$8,750	$43,750	32		To provide necessary transportation of NASA and contractor personnel at domestic and foreign installations.
Station wagons	28	54,600	11	4,400	50,200	23		For transportation of personnel, supplies, and equipment at domestic and foreign installations.
Busses	1	15,000	1	2,500	12,500	4	41,000	For transportation of NASA and contractor personnel between widely dispersed research facilities and remotely located research stations; visiting dignitaries, committee and conference members.
Ambulance	1	7,500	1	150	7,350	1		For use where medical facilities are inadequate.
Total	65	129,600	38	15,800	113,800	60	42,300	

[1] Other than to Government motor pools.

Statement of proposed obligations for purchase, maintenance, and operation of aircraft for the fiscal year 1960

Appropriation	Aircraft to be purchased		Aircraft to be exchanged		Net cost of aircraft to be purchased	Old aircraft still to be used	Cost of maintenance and operation of aircraft	Users and public purpose
	Number	Gross cost	Number	Allowance (estimated)				
Research and development, National Aeronautics and Space Administration.						[1] 8	[2] $130,000	Aircraft to be used in the field by officials and designated employees primarily for research and space activities and for transporting personnel and equipment to remotely located field installations.

[1] Includes 3 aircraft on loan from the Military Services.

[2] Passenger trips only.

Summary of passenger motor vehicles—Fiscal year 1960 estimates

Activity	Number on hand start of fiscal year 1960					Motor vehicles to be purchased in fiscal year 1960					Old vehicles still to be used					Number on hand end of fiscal year 1960				
	Sedans	Station wagons	Buses	Ambulances	Total	Sedans	Station wagons	Buses	Ambulances	Total	Sedans	Station wagons	Buses	Ambulances	Total	Sedans	Station wagons	Buses	Ambulances	Total
NASA headquarters	1				1						1				1	1				1
Langley Research Center	7	5			12						7	5			12	7	5			12
Ames Research Center	4	2			6						4	2			6	4	2			6
Lewis Research Center	4	4	2	1	11	1	4			5	3	3	2	1	9	4	7	2	1	14
High-Speed Flight Station	1	2			3						1	2			3	1	2			3
Beltsville Space Center:																				
Domestic installations	1	6			7	3	7			10	3	4			7	6	11			17
Foreign installations	6	7			12	3	11			14	4	2			6	7	13			20
Pilotless Aircraft Station		2	2		4							2	2		4		2	2		4
Patrick office							1			1							1			1
Western office	1				1	1				1	1				1	2				2
Jet Propulsion Laboratory	32	7	1	1	41	27	5	1	1	34	8	3			11	35	8	1	1	45
Total	57	34	5	2	98	35	28	1	1	65	32	23	4	1	60	67	51	5	2	125

Source of passenger-carrying vehicles

	Sedans	Station wagons	Buses	Ambulances	Total
Procured by NASA	1	2			3
Transferred from NACA	18	15	4	1	38
Transferred from Army Ordnance (Jet Propulsion Laboratory)	32	7	1	1	41
Transferred from Army Map Service (Vanguard project)	6	10			16
Total	57	34	5	2	98

Passenger-carrying vehicle requirements—Fiscal year 1960 estimates

Age year	On hand, start of fiscal year 1960					Requested replacements, fiscal year 1960				
	Sedans	Station wagons	Buses	Ambulances	Total	Sedans	Station wagons	Buses	Ambulances	Total
1	8	5			13					
2	3	4			7					
3	4	8			12					
4	23	7	2		32	8	4			12
5		7			7		6			6
6	1				1					
7		2			2					
8		1	2		3		1			1
9	18		1	1	20	17				17
10 and over				1	1			1	1	2
Total	57	34	5	2	98	25	11	1	1	38

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